FEDERAL REPUBLIC OF NIGERIA

Annual Report on the Department of Agricultural Research

For the Year 1961 - 62

REPORT BY THE DIRECTOR

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1964

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STAFF LIST AS AT 31ST MARCH, 1962

MOOR PLANTATION, IBADAN

Director of Agricultural Research ...	J. M. Waterston, B.Sc., Ph.D. (Edin.), F.L.S., A.I.C.T.A.
Deputy Director of Agricultural Research	B. N. Webster, M.A. (Cantab.), M.Sc. (Nott.), M.I. Biol.
Senior Accountant	R. J. Luton
Librarian	(Miss) N. I. Shinie, B.Sc. (Edin.), A.L.A.
Higher Executive Officer	S. B. Alalade†
Executive Officer	M. O. Ojekwe
Agronomists	M. H. F. Fyfe, B.Sc (Aberd.), Dip. Agr. I.C.T.A. (Trinidad).
	P. M. Chinwuba, B.A. (Calif.), B.Sc. (Lincoln), M.Sc. (Miss.).
	F. O. C. Ezedinma, B.Sc., M.Sc. (Lond.).
Botanist	C. L. M. van Eijnatten, L.i. (Wageningen).
Chemists	*M. N. Nwaji, B.Sc. (Lond.).
	*M. N. Okafor, B.Sc. (Lond.).
	*E. N. Ugochukwu, B.Sc. (Lond.).
Entomologists	F. A. Squire, B.Sc. (Rhodes), A.I.C.T.A.
	T. A. Taylor, B.Sc. (Lond.), Ph.D. (Durham).
	S. O. Boboye, B.Sc. (Lond.).
Pathologists	A. G. Bailey, B.Sc. (Lond.), D.A.S., D.T.A.
	D. G. Robertson, B.A. (Oxon.), D.A.S.
	†S. A. Anibaba (Miss), B.Sc. (Lond.).
Plant Physiologist	R. Spencer, B.Sc. (Lond.).
Statistician	†B. Afonja, B.Sc. (Lond.).
Technical Officers	J. K. Olurin
	N. N. Okparanta
Laboratory Technologist	S. N. Muotoe
Station Manager	S. A. Soremi

BADEGGI SUB-STATION

Principal Research Officer (and Botanist)	J. E. Y. Hardcastle, B.Sc. (Dunelm), D.A.S., D.T.A.
Agronomist	T. J. Bredero, L.i. (Wageningen).
Botanists	B. D. A. Beck, B.Sc. (Manc.), D.A.S., D.T.A.
	J. A. F. M. Sluyters, L.i. (Wageningen).
Station Manager	E. D. Oddy, Dip. Hort. (Wisley).

* Undergoing Post-graduate in-service training.

† Acting.

Umuahia Sub-station

Botanists	A. W. Waitt, B.Sc. (Edin.), D.A.S., D.T.A. Th. van der Feijst, L.I. (Wageningen).
Technical Officer	M. J. Ekandem

Samaru

Entomologist	K. M. Harris, B.Sc. (Wales), D.A.S., D.T.A.

Lagos Plant Quarantine Station

Technical Officer	J. A. Obi

Calabar Plant Quarantine Station

Technical Officer	A. O. Bamtefa

Kano Plant Quarantine Station

Technical Officer	E. A. Dosunmu

Research Fellowships

Name	*Place of Tenure*	*Subject*
P. Ward, B.Sc. (Liverpool)	University College, Ibadan	Quelea Investigations
S. N. C. Okonkwo, B.Sc. (Lond.)	University College, Ibadan	Striga Investigations

Visiting Specialists

P. B. Collins, B.Sc. (Lond.), Research Information Adviser.

T. Heikkinen, B.S., M.S., Ph.D. (Wisconsin), Soil Fertility Specialist (F.A.O.)

P. R. Hesse, Ph.D. (Lond.), F.R.I.C., Chemist (Rice Research).

J. Takahashi, Dr Agr. Sci. (Tokyo) Chemist (Rice Research).

A. Vaillant, Dip. Hort. (Versailles), Dip. Trop. Agri. (Nogent) Agronomist (Rice Research).

Annual Report on the Department of Agricultural Research, Federation of Nigeria, for the Year 1961-62

REPORT BY THE DIRECTOR

Introduction

An important statement of policy was announced by the Hon. Minister of Economic Development during the period under review[1] which was later reflected in the Development Programme, 1962-68[2]. The new programme accords the highest priority to agriculture, as well as to industry and technical education and marks a major increase in investment by the Federal Government in the field of primary production, with special emphasis on the application of the results of agricultural research to the development of regional natural resources programmes. Details have yet to be worked out in consultation with Regional Ministries but expenditure of up to £25 million in the form of loans and grants to assist Regional Governments in the expansion of their programmes for specific approved projects in agriculture, veterinary, forestry and fisheries services is anticipated.

The programme also makes capital provision of £1.46 million for the continuance of agricultural research. Details are mentioned in a later part of this report, where progress achieved in the 1955-61 plan is also reviewed.

There were no changes in the Department's main lines investigation which continued to be concerned with the improvement of food crops and related factors including soil fertility, and the control of diseases and pests. Details of work will be found under the appropriate headings in the sections dealing with the progress of research which follow this report.

Facilities for the plant quarantine service were greatly improved by the completion of a specially designed station at Moor Plantation, Ibadan, and have now been officially approved by a sub-committee appointed by the Inter-African Phytosanitary Commission. Nigeria acceded to the Phytosanitary Commission for Africa South of the Sahara, 1954, as amended by Protocol of 11th October, 1961, on 8th October, 1961, in accordance with Article 11 of the Convention.

Good progress was also made in the construction of new laboratories, and a library, museum and conference room at Moor Plantation and eight senior staff houses. Work on the Rice Research Station, Badeggi was also almost completed during the year, and a start was made at Umudike in the provision of laboratory and housing facilities for the Soil Fertility and Root Crop Research Unit. As a result of these improved facilities, the Department was able to take advantage for the first time of offers of staff under technical assistance schemes, and at the end of the period under review, five visiting scientists were working on Federal projects in Nigeria. The conference room facilities were in great demand and

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1 Alhaji the Hon. Waziri Ibrahim, M.P. (1961) Ministerial Statement on Nigeria's Economic Planning Policy and its Relationship with Distributive Trades and Road Transportation, made in the House of Representatives during the Supplementary Budget Session, 22nd November, 1962. Federal Printing Division, Lagos.

2 Federal Government Development Programme 1962-68. Sessional Paper No. 1 of 1962. Federal Printing Division, Lagos.

Moor Plantation was the venue for the Sixth Meeting of the Inter-African Phyto sanitary Commission and the C.C.T.A./F.A.O. Symposium on Weed Control in October 1961.

Staff

The recruitment and retention of scientific staff remains a serious problem but it is heartening to be able to report that there are now nine Nigerian Specialist Officers on the staff with a further 21 Nigerians undergoing University training to qualify themselves for professional appointments in the Department.

The department lost four senior officers through retirement or on expiration of contracts: Mr J. L. Gregory, Entomologist; Mr L. A. Mound, Entomologist; Dr G. P. Tewari, Agronomist; and Dr F. C. Bent, Agronomist. These losses were offset by the appointment of six new recruits: Mr B. N. Webster, Deputy Director of Agricultural Research; Mr F. O. C. Ezedinma, Agronomist; Mr S. O. Boboye, Entomologist; Dr T. A. Taylor, Entomologist; Mr E. N. Ugochukwu, Chemist and Mr M. H. D. F. Fyfe, Agricultural Officer. As a result of these staff movements, there was an overall increase of two Specialist Officers which is shown in Table I.

The authorised establishment of Senior Staff at the beginning of the year and the actual strength at 31st March, 1962 are given below. It will be noted that there were 29 vacancies in an establishment of 81, which is an improvement over the previous year.

Professional	*Authorised*	*Actual*
Director	1	1
Deputy Director	1	1
Principal Research Officers	3	2
Senior Specialists and Specialists	33	20
Scientific Officers	2	—
Librarian	1	1
Total Professional Staff	41	25
Higher Technical Staff		
Technical Officers	6	6
Assistant Technical Officers	11	10
Laboratory Technologists	3	1
Assistant Laboratory Technologists ...	5	1
Mechanical Demonstrator	1	—
Station Managers	2	2
Total Higher Technical Staff	28	20

Executive	*Authorised*	*Actual*
Senior Accountant	1	1
Higher Executive Officer	1	—
Executive Officers	2	2
Assistant Executive Officers	4	3
Records Officer	1	—
Personal Secretary	1	1
Total Executive Staff	10	7
Grand Total Senior Staff	79	52

The corresponding position for Junior Staff at 31st March, 1962 showed a total of 47 vacancies in an establishment of 239 as follows:—

Clerical		
Chief Clerk	1	1
Assistant Chief Clerks	2	2
First Class Clerks	11	8
2nd and 3rd Class Clerks	21	21
Stenographer	1	1
Library Clerks	2	1
Storekeeper	1	1
Total Clerical Staff	39	35

Technical		
Senior Agricultural Assistant, Grade I	1	.
Senior Agricultural Assistants, Grade II	6	2
Agricultural Assistants, Grade I	9	4
Agricultural Assistants, Grades II and III	55	36
2nd and 3rd Class Agricultural Laboratory Technicians	6	1
Photographic Assistant, Grade I	1	1
Draughtsman, Grade II	1	1
Total Technical Staff	79	46

Minor Technical and Clerical (Scale F)		
Senior Field Overseers	6	5
Field Overseers, Grades I and II	56	50
Artisans	10	10
Driver-Mechanics	8	8
Clerical Assistants	12	9
Typists	7	9
Meteorological Recorder	1	1
Total Minor Technical Staff	100	92

Sub-clerical and Minor Technical (Scale G)	*Authorised*	*Actual*
Senior Laboratory Attendant ..	1	1
Laboratory Attendants	5	5
Stores Attendant	1	1
Telephone Attendants	3	1
Messengers	11	11
Total Sub-clerical and Minor Technical Staff..	21	19
Grand Total Junior Staff	239	192

PROGRESS OF NIGERIANISATION AS AT 31ST MARCH, 1962

	Nigerian	*Expatriate (P)*	*(C)*	*Vacant*	*Total*
Professional	9	8	8	18	43
Higher Technical ..	19	—	1	8	28
Technical	46	—	—	33	79
Minor Technical ..	92	—	—	8	100
Executive	5	—	2	3	10
Clerical	35	—	—	4	39
Sub-clerical	19	—	—	2	21
Total	225	8	11	76	320

(P)=Pensionable (C)=Contract terms

Nigerians undertaking higher training at the present time to qualify themselves for posts in the Department are as follows :—

NUMBER OF STUDENTS

Subject	*Diploma*	*B.Sc.*	*M.Sc.*	*Ph.D.*	*Total*
Agriculture	—	3	1	—	4
Botany..	—	5	1*	2	8
Chemistry	—	3	2*	1*	6
Statistics	1*	—	—	—	1
Zoology	—	1	—	1	2
Total	1	12	4	4	21

Progress in Research 1955-61

The period reviewed in this report covers the last phase of the economic programme for 1955-61. It would therefore appear opportune to review briefly the progress made to date as it affects this Department and to relate this to the future plans in the Development Programme for 1962-68.

Organisation.—A Council of Natural Resources was established in June 1955 to work out details of a co-ordinate policy of research on a national basis[3]. For each field of research (Agriculture, Forestry, Fisheries and Animal Health and Husbandry)

* Undergoing In-service Training.

3 White Paper on Natural Resources (Lagos, Government Printer CP 29/55/2 of 10-6-55).

there was established a Technical Committee with the main duties of formulating research programmes, assigning projects and determining priorities. These Technical Committees have continued to meet regularly since 1955 and have served a most useful function for co-ordination of research at a professional level. The Agricultural Technical Committee, for example, consists of representatives of all Regional Ministries of Agriculture and Natural Resources and the Faculties of Agriculture of the Universities of Ibadan, Ife and Nigeria (Nsukka), with the Director of Agricultural Research as Chairman. Research programmes are reviewed annually by the Technical Committees to ensure that regional requirements are being met as far as available funds and staff permit.

The original plan proposed the development of the Department into a Nigerian Institute for Agricultural Research along the lines recommended by the International Bank Mission Report[4], and the Engledow Report[5] but no action has yet been taken by Government to establish a Nigerian Institute for Agricultural Research, although enabling legislation for such action was passed (No. 35 of 1959). The Headquarters of the organisation were to be at Moor Plantation with a sub-station for rice research at Badeggi, and another for soil fertility and root crops at Umudike. The main terms of reference were research on food crops and related problems of factors limiting production such as soil fertility and diseases and pests. In addition, the organisation was charged with the responsibility for maintaining a Federal Plant Quarantine Service, at Ibadan, Kano and Calabar as well as for providing liaison between research workers in the regions.

The development of the programme concerned with agricultural research got off to a slow start as a result of difficulties encountered in the acquisition of sites for research facilities, as well as deficiencies in executive capacity of Regional Ministries of Public Works to carry out construction programmes. With the exception of housing at Ibadan and Umudike, considerable progress was made in implementing the programme for expansion of research facilities, particularly at the Headquarters at Moor Plantation and at the Rice Research Station at Badeggi. Good progress was made in research on food crops with particular reference to rice, maize and cassava, the only limiting factor being shortage of trained staff.

Staff Training.—The shortage of scientists in Nigeria remains the major factor impeding progress in the Economic Programme for Agricultural Research. The need to intensify efforts to produce more scientists has been stressed by the Parliamentary Committee on the Nigerianisation of the Federal Public Service (page 32, paragraph 12 of Sessional Paper No. 2 of 1960).

This is necessarily a slow process as it takes a minimum of six years to produce fully qualified research worker. It is however encouraging to note that the number of Nigerian scientists in the Department rose from none to nine in the period under review and that there are at least a further 21 in training with a view to filling existing vacancies.

Research Facilities.—The following summarises the progress made to date in implementing the Economic Programme 1955-61.

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4 The Economic Development of Nigeria (Lagos, Government Printer, 1954).

5 Report by Sir Frank Engledow, C.M.G., F.R.S., on the Federal Organisation for Agriculture, Veterinary, Forestry and Fisheries Research. Sessional Paper No. 4 of 1959. (Lagos: Federal Government Printer).

Moor Plantation.—When the new Constitution came into effect on 1st October, 1954, both Federal and Western Region Governments made claims to take over Moor Plantation which up to then had been the old Central Government Agricultural Headquarters. After five years of protracted negotiations it was finally agreed to divide Moor Plantation between the Federal and Regional Governments, the portion north of the Ibadan-Abeokuta road being retained as a headquarters for the Federal Department of Agricultural Research. The delays experienced in settling the future of Moor Plantation caused a serious set-back in the implementation of the Economic Programme, particularly with regard to the provision of houses and laboratories. Without these facilities it was not possible to seek technical assistance for experts to fill the gap caused by the retirement of expatriate staff and the departure of Nigerians to undertake training courses to fit them for professional posts.

The delays experienced in settling the future of Moor Plantation also held up the establishment of the soil fertility unit and food crop research team at Umudike, since the purchase of land in the East could not be arranged until the final figure for compensation to be paid to the West was known. The development of these projects has therefore had to be carried over to the next 6-year programme.

An expansion of facilities took place in 1956 with the erection of a laboratory and screen-houses for the West African Cocoa Research Institute's Nigerian Station and in 1960 eight senior staff houses were constructed for the Federal Department of Agricultural Research.

The year 1960 also saw the start of work in the new laboratories, library, conference room and museum at Moor Plantation and in 1961 of the Plant Quarantine Station. These projects have been completed. The most pressing need now remains for the construction of the spectrographic laboratory (funds for which have recently been allocated) and for extensions to the chemistry laboratory. These, when completed will enable our Department to supply the regions with a service for the spectrographic analysis of soils and plant tissues required in studies on crop nutrition and the maintenance of soil fertility.

Badeggi.—The development of the rice research sub-station at Badeggi has proceeded with fewer difficulties than those experienced at Ibadan. Building operations started in 1956 and were completed in 1960. Laboratory accommodation is now provided for four plant breeders, two agronomists and a chemist under the direction of a Principal Research Officer.

Umudike.—Following the settlement of Moor Plantation, a start was made with the establishment of a laboratory and junior staff quarters at Umudike for the study of the maintenance of soil fertility. It is planned to house the Federal root-crop research team of 8 senior officers at this regional station as well.

Calabar.—The plant quarantine sub-station at Calabar has been completed and is in operation.

Kano.—The plant quarantine sub-station at Kano is almost completed but requires provision for junior staff quarters.

Lagos.—A plant quarantine office has been opened at Apapa Wharf which has permitted much closer co-operation with the Board of Customs and Excise in the Control of plant importations at this sea-port as well as at Ikeja airport.

Research Achievements.—Some of the noteworthy achievements of Federal research are improvements in crop husbandry, and improved disease and pest control.

Rice.—The introduction of white rice into Nigeria by the Department of Agriculture took place less than 50 years ago. Present day production amounts to 250,000 tons per annum. While the bulk of annual crop is still grown in the Northern Region, cultivation is expanding rapidly in the Eastern Region where production has grown from nothing to 50,000 tons in 15 years since 1944. During the past 7 years, this Department's rice breeders and agronomists have been able to double the yields of rice normally obtained by farmers through the introduction of improved varieties and better methods of crop husbandry. The potential value of this work is £14 million per annum. A rice seed multiplication scheme, operated in conjunction with the Regional Ministries of Agriculture, ensures the rapid distribution of improved varieties as they are produced.

Maize.—Maize research was started in 1951 to combat severe losses caused by maize rust diseases. New varieties have now been produced which are not only disease resistant but which have given a 50 per cent increase in yield as well. The variety ES-1, which took 5 years to produce, has proved high yielding in all parts of the Federation and has increased the potential value of the crop by £7 million. Up to the present 10 cwt. of breeder's stock of seed has been made available annually to Regional Ministries of Agriculture which when multiplied will produce 500 tons of improved maize seed for distribution to farmers.

Cassava.—The present national yield of cassava is 4 tons per acre. New hybrids produced by the Federal Botanist during the past 5 years are capable of yielding 10 tons per acre. Furthermore the response of these new hybrids to fertilisers is greater than that of the unimproved cassava. In one trial at Kabba, 1 cwt. of sulphate of ammonia caused a 50 per cent increase in yield of hybrid cassava and only 20 per cent increase in the unimproved material. The potential value of these improved varieties is enormous.

Yams.—The average yield of yams in Nigeria is around 4 tons per acre. The Botanist has produced new selections which show potential yields almost twice this.

Achievements in improved control of diseases and pests on cocoa and yams are noteworthy.

Cocoa.—The Federal Plant Pathologist started research on black pod disease control in 1950 and produced a successful method of spraying four years later which was eagerly taken up by the cocoa farmers of the Western Region. Training schemes to teach farmers how to spray were initiated by the Western Region Ministry of Agriculture and so successful were these efforts that five years after spraying was first introduced, over 99,866 farmers were receiving training in one year. The amount of cocoa saved from destruction has been calculated from direct observation as 20,000 tons annually, worth £4.5 million.

As a result of this work as well as that on capsid control and the introduction of higher yielding varieties developed by the West African Cocoa Research Institute, it is now possible for the cocoa farmer to produce much greater returns per acre. This will permit in future years a more intensive production of the crop from smaller areas, thus releasing land for other purposes.

Yams.—The yam industry is at present valued at £95 million. Of this amount one third is produced in riverain areas which are subject to the ravages of the yam beetle. The Federal Entomologist has shown that the application of insecticidal dusts has increased yields in these areas by 20 per cent so that the increase in yam production amounts to £6.0 million.

The immediate results of this research are most obvious in the field of disease and pest control but the greatest potential avenue for advance lies in the improvement of crop husbandry through the use of better varieties and more intensive systems of cultivation.

This can be achieved by the closest co-operation between research and extension workers.

The Development Programme 1962-68

Reference has already been made to the emphasis on primary production in the Federal Economic Development Programme projected for 1962-68, and the recognition of the need for expansion and modernisation of agriculture, not only to permit a more efficient supply of export products for revenue but to ensure that domestic food production is expanded to cater for a better level of nutrition of the people, and at the same time reduce dependence on imported foodstuffs. Coupled with this is Government's recognition of the need, already stressed by Dr B. R. Sen, Director-General of F.A.O., for an accelerated adaptation and use of proven methods of scientific agriculture, if increased production of food is to be achieved.

This will entail surveys and investigations into ways and means of increasing efficiency of production and processing of natural resources with a view to the provisions required for the following:

(*a*) the needs of the rapidly increasing population which is expected to reach 75 millions well before the year 2,000, provided the present rate of increase of 2% is maintained.

(*b*) the achievement of a substantial increase in the standard of living.

(*c*) increased production to meet the needs of industrialisation and urbanization.

(*d*) the development of a more efficient use of land and water.

It is hoped to obtain answers to some of these problems in the forthcoming F.A.O. Agricultural Survey of Nigeria.

The Department of Agricultural Research in the past has concentrated on the improvement of staple food crops of interest to all three regions in the Federation. This work on rice, maize, cassava, yams and grain legumes will be expanded within Regions, including research facilities on soils and root crops at Umudike.

Special attention will be given in the new programme to soil fertility and fertilizer studies in conjunction with the cultivation of new and improved varieties of crop plants produced by the plant breeders. This will be co-ordinated with Regional Governments' investigations, crop improvement programmes as well as with the F.A.O. Fertilizer Programme and should provide a basis for a major contribution to the Freedom from Hunger Campaign.

The Department of Agricultural Research will also expand its Specialist Services by establishing a spectrographic laboratory at Ibadan for the analysis of soils and plant tissues and proposes to strengthen the Plant Quarantine Service with the addition of a Botanical Garden at Jos for the introduction and acclimatisation of new plants of economic importance.

Visiting Missions

A team of five experts from the International Bank for Reconstruction and Development visited the Federation of Nigeria in June 1961 for seven weeks, to review the progress of Nigeria's economy since their last comprehensive survey in September to December 1953.

A comprehensive report on rubber research in the Federation of Nigeria and the Cameroons was submitted in August 1961 by Messrs C. W. Brookson, J. E. Morris and Wong Mun Yun. The mission which visited Nigeria from 19th October to 12th December, 1960, recommends the establishment of a National Rubber Research Institute to cater for the needs of the industry in Nigeria, with main laboratories and plantation near Benin City, in Western Nigeria and a sub-station at Akwete in Eastern Nigeria.

Meetings of Research Workers

An Agricultural Conference held at the University of Nigeria, Nsukka, from 2nd to 4th August, 1961 was well attended and included representatives of Federal and Regional Ministries of Agriculture and Economic Development, F.A.O., and I.C.A. Distinguished visitors from abroad included Dr T. K. Cowden, Dean of Agriculture, Michigan State University, U.S.A.; Professor D. Skilbeck, Principal, Wye Agricultural College, Kent, England; Professor D. Hendrie, Principal, West of Scotland Agricultural College, Glasgow, Scotland and Mr J. H. Smith, Agricultural Economist, Marischal College, Aberdeen, Scotland.

The Ninth and Tenth Meetings of the Agricultural Technical Committee were held at Ibadan on 27th to 29th November, 1961 and 25th to 29th January, 1962, respectively.

A joint meeting of Agricultural, Fisheries, Forestry and Veterinary Technical Committees was also held at Ibadan on 27th to 29th November, 1961, to discuss projects for a proposed F.A.O. Agricultural survey of Nigeria.

The Fourth Annual Conference of the Science Association of Nigeria was held at Enugu on 15th to 19th December, 1961. Subjects discussed included an important symposium on agriculture, protein and nutrition in Nigeria.

Research Seminars continued to be held at regular intervals at Moor Plantation and were well attended by staff from Federal, Regional and University agricultural research organisations.

Conferences

The Sixth Meeting of the Inter-African Phytosanitary Commission was held at Moor Plantation, Ibadan from 16th to 20th October, 1961, and was opened by the Hon. C. I. Akere, Regional Minister of Agriculture, Western Nigeria, who gave an Inaugural address in the presence of 45 delegates and observers.

The recently completed Federal Plant Quarantine Station at Moor Plantation was inspected by a sub-committee appointed by the Commission, who expressed their approval of the facilities provided, subject to minor modifications which are being adopted.

A C.C.T.A./F.A.O. Symposium on Weed Control was held at Moor Plantation, Ibadan from the 23rd to 27th October, 1961. The Symposium was the first of its kind to be held in West Africa and was well attended by specialists from East, West and South-Central Africa. The inaugural address was given by the Hon. F. U. Mbakogu, M.P., Parliamentary Secretary, Ministry of Economic Development, in the presence of 45 delegates and observers.

Special attention was paid to problems of weed control in African agriculture with particular reference to techniques for applying chemical weed-killers. The dangers of aquatic plant pests to navigation and large dam projects were also discusssed.

A Conference on Natural Resources Development was held at Moor Plantation, Ibadan, on 30th and 31st January, 1962, to work out how best the Federal Government could contribute to Regional Agricultural Development in the 1962-68 National Plan. The meeting was attended by all the Federal and Regional Ministers concerned with agriculture and economic development.

Inter-Territorial Research Committee

Meetings of the Management Committees and Technical Sub-Committees of the West African Cocoa Research Institute and the West African Institute for Oil Palm Research were regularly attended and the needs of all Regions kept in view.

Distinguished Visitors

The Department was honoured by the following distinguished visitors:—

His Grace the Duke of Devonshire, Commonwealth Relations Office, London; Mr W. Railston, Department of Technical Corporation, London; the Hon. F. U. Mbakogu, M.P., Ministry of Economic Development, Lagos; His Excellency the Pakistan High Commissioner, Mr K. Shakabuddin; His Excellency Dr Louis Noe, the Netherlands Ambassador; His Excellency Mr E. L. Kennedy, Ambassador for Ireland; His Excellency M. Giovanni Enrico Bucher, Ambassador for Switzerland; His Excellency Dr Carlo Enrico Giguoli, Ambassador for Italy; the Hon. Waziri Ibrahim, Minister of Economic Development; Alhaji the Hon. Mohammed Mustafa, Regional Minister of Agriculture, Kaduna; the Hon. Muazu Lamido, Minister of Animal and Forest Resources, Kaduna; the Hon. G. I. Akere, Regional Minister of Agriculture and Natural Resources, Ibadan and the Hon. P. N. Okeke, Regional Minister of Agriculture, Enugu.

Visiting Scientists

Visiting Specialists who spent six months or more working in Nigeria were Mr P. B. Collins, Research Information Adviser (U.K. Technical Assistance); Dr T. Heikkinen, Soil Fertility Specialist (F.A.O.); Dr P. R. Hesse, Rice Research Chemist (West African Rice Research Station); Dr J. Takahashi, Rice Research Chemist (U.N.T.A.B.) and Mr A. Vaillant, Rice Research Agronomist (F.A.M.A./C.C.T.A.).

Other visiting Scientists included:—

Dr F. W. Hauck, F.A.O., Rome; Dr S. D. Garrett, Botany School, University of Cambridge; Mr E. N. G. Smith, Tropical Products Institute, London; Dr C. Cheysson, C.C.T.A., Lagos; D. W. O. Jones, Food Research Institute, Stanford, U.S.A.; Mr Oristides J. Macris, F.A.O., Rome; Mr R. Rowat, F.A.O.; Dr Ephraim Hixson, I.C.A., India; Dr P. R. Hesse, West African Rice Research Station, Sierra Leone; Dr E. Bampton, Tropical Products

Institute, London ; Dr A. G. Salah, Dr H. M. Ismail, Dr M. Kassas, Dr N. M. Shukri, University of Cairo ; Dr D. Y. Ruston, E.C.G.C., London ; Dr Herbert Greene, Adviser on Tropical Soils and Mr A. J. Vernon, Rothamsted Experimental Station, Harpenden, England ; Dr Loren L. Davis, Rice Agronomist, A.I.D. ; Dr John J. McKelvey jr., the Rockefeller Foundation, New York, U.S.A. ; Mr R. Vries, Agricultural Attache, Embassy of the Netherlands ; Dr E. B. Worthington, Nature Conservancy, London and Mr J. B. Davis, U.S.A.I.D., Lagos.

Visits by specialists to neighbouring Regions and Territories outside Nigeria

Dr J. M. Waterston, Director of Agricultural Research, visited the Netherlands from 18th to 28th April, 1961, to study the agricultural research and training facilities in the light of Nigeria's needs.

Mr F. A. Squire, Principal Research Officer (Entomology) attended the O.I.C.M.A. Conference at Bamako, 2nd to 7th May, 1961 as adviser with the official Nigerian delegate, Dr Odetoyinbo. He also visited O.R.S.T.O.M. at Adiopodume, near Abidjan.

Mr P. M. Chinwuba, Agronomist, visited Mexico and the United States from 7th April to 15th August, 1961, and Mr L. A. Mound, Entomologist, visited the United States of America from 11th April to 5th May, 1961, both on Rockefeller Foundation Travel Grants.

Mr J. E. Y. Hardcastle, Principal Research Officer, visited the West African Rice Research Station at Rokupr on 15th December, 1961 to represent the Director of Agricultural Research in the Fifth Meeting of the West African Rice Research Station Management Committee. He had earlier visited Gambia and Senegal from 5th to 19th October, 1961.

Once again, it is a pleasure to record our grateful appreciation of the continued interest and helpful assistance received from the Commonwealth Agricultural Bureaux and the Rothamsted Experimental Station. We would also like to record our gratitude to the Rockefeller Foundation for the award of two Travel Grants to members of our staff which enabled them to pursue advanced studies in maize breeding and insect taxonomy.

J. M. WATERSTON,
Director of Agricultural Research

29th June, 1962.

PROGRESS IN RESEARCH
PLANT PHYSIOLOGY

CROP NUTRITION

Growth Analysis of Cassava (Mr R. Spencer ; Mr S. N. Muotoe)

This experiment is a replication of last year's experiments. Cassava plants were grown in drums, where nutrient supply and water could be regulated, and on the field. The time of planting was changed to coincide with the normal planting time of cassava in the Ibadan area, that is about May.

The materials used for planting were 2 years old. It was discovered that the cuttings had rooted poorly and they had to be replaced with materials of about 12-18 months old. These gave 100 per cent rooting. Due to poor soils, the experiment with cassava planted in the field had to be cancelled.

The rate of growth of the plants in the drums was found to be lower than in the previous experiment even though the latter was planted out of season, in December, and had to be watered. The cause may be due to climatic factors prevailing during the period of the experiment.

The data have been collected and are awaiting statistical analysis.

Leaf Development of Cassava

12 cuttings from plants of 12-18 months old are being used in this experiment to study the rate of leaf production and leaf expansion in cassava. The number of leaf scars and leaves are counted and the leaf area is measured at weekly intervals. Leaf area is obtained from linear measurements by methods described earlier. As the method is non-destructive, the leaf area measurement of the cassava is being continued to cover the full life cycle, that is for about 18 months.

The results so far obtained show a similar expansion of leaf area in all plants, the relation of area with time being sigmoid during the early stage of rapid expansion and the area later decreasing when the leaves absciss. This reduction in area coincides with the beginning of the dry season.

Sweet Potato Fertiliser Experiment at Ilora

The aim of the experiment is to determine the effect of fertilizers on sweet potato yields. The main treatments are N, P and K at three levels superimposed on three levels of Ca, Mg and a trace element dressing. The layout is $3\times3\times3$ factorial. Nitrogen is applied as sulphate of ammonia at the rate of 30 lbs. of nitrogen per acre, phosphate as superphosphate at the rate of 40 lbs. per acre ; calcium as Buxton lime at the rate of 42 lbs. CaO per acre ; magnesium as magnesium sulphate at the rate of 20 lbs. MgO per acre. The trace element dressing is constituted as a mixture of manganese sulphate 5 lbs. ; Borax 1 lb. ; zinc sulphate 7 lbs. ; copper sulphate 6 lbs. ; ammonium molybdate 2 oz. ; ferrous sulphate 10 lbs. It is supplied at the rate of 14 lbs. 9 ozs. per acre.

The plot size is 0.01 acre. The vines were planted one foot on 3 foot ridges. The sweet potato variety planted is 2,294 (ex Moor Plantation). During harvesting, weights of both the vines and tubers were recorded. The data obtained are being assembled for statistical analysis.

Working Shelter

The working shelter has been completed. There has been some difficulty in obtaining demineralised water due to leakage of polythene columns, which started to show cracks when exposed in the working shelter. This may be attributed to the effect of sunlight. New columns have been ordered and necessary precautions will be taken on arrival.

BOTANY

TREE CROPS

Coffee

Yield Figures.—Harvesting and individual tree yield recording continued for the second year following pruning. With the exception of a few lines, there was a gradual rise in yield from several bearing trees in the collection. The following were the yields recorded.

Table Showing 1961 Yield of Coffee Recorded from half/acre Plots on Moor Plantation : Expressed in Lbs Fresh Berries

Plot	*Type*	*Year of Coppicing*	*Trees in Bearing*	*Yield (lbs)*	*Mean Yield per Bearing Tree (lbs)*
A	C. Robusta	1959	109	253	2.3
B	C. Liberica I	1953	111	485	4.4
C	Quillou Robusta ..	1959	119	395	3.3
D	C. Stenophylla	1960	25	5	0.2
E	Java Robusta	1959	102	195	1.9
F	C. Arabica	—	23	2	0.1
G	Uganda Robusta ..	1959	110	227	2.0
H	C. Liberica II	1953	97	407	4.3
J	C. Excelsa	1960	70	30	0.4
K	Uganda No. 1	1960	28	14	0.5

Coppiced Trees.—The coppiced trees continue to make an encouraging growth ; three bearing branches were maintained per tree and a fourth encouraged to develop. At the end of the dry season the oldest bearing branch will be cut back, to be replaced with the newly developed one. It is intended to repeat this process annually in order to provide for a regular replacement of the ageing bearing branches.

Shade.—The gliricidia stands which hitherto formed the shade have now been completely cut back ; the stumps were allowed to sprout, and the spread of the canopies kept in check. The superfluous suckers were removed. Seedlings of *Albizzia falcata* and of *A. sassa* were planted to provide permanent cover. The albizia's made a good growth in most of the plots.

Kola

Compatibility of Kola.—A number of high yielding trees in the kola plantation maintained at Agege were artificially pollinated to investigate their self-and cross-compatibility. It appears that the high yielding tree AA231 produces fruits when pollinated with pollen from trees AA31 and AA176. The two highest yielders AA86 and AA231 seem to be self incompatible but produced some fruits when cross pollinated.

White Kolanuts for Distribution.—Artificially controlled pollinations have been carried out to produce seeds for distribution from the *Cola nitida* material available at Moor Plantation (ex Labochi, Bida Emirate, and ex Sierra Leone) and at Gambari (ex Labochi). A total of 2,875 nuts was thus obtained.

Study of Inheritance of Nut Colour.—The study of inheritance of cotyledon colour in the F1 hybrid population of the Kola trees in E5 was continued. Six trees from a total of 31 trees and the red x red trees bred true for pink and red nuts respectively.

Rooting of Kola.—It was discovered from a number of experiments carried out in 1960 and 1961 that the following conditions must be fulfilled in order to obtain a successful rooting of kola cuttings: (1) Cuttings should be 2-4 months old, vigorous and just beginning to be woody; (2) A high relative humidity should be maintained in the rooting bins; (3) Fresh sawdust appeared to be a better rooting medium, than soil or soil-sawdust mixtures.

FOOD CROPS

Maize (Mr C. L. M. van Eijnatten; Mr P. M. Chinwuba; Mr N. N. Okparanta)

Co-operative Uniform Trials.—Co-operative uniform trials in a number of the important maize growing areas in the country were started in earnest in 1960. Two trials are carried out in each year at a single location in the Western Region, where there are two general periods of maize planting, one early and one late. In the Northern Region, maize is not normally planted in the late season because the rainfall is not sufficient for a successful production of maize.

Early season trials

TABLE 1.—COMPARATIVE YIELD DATA : 1961

	Western Region			*Eastern Region*			*Northern Region*			*Average*
	Ondo	*Akure*	*Ipokia*	*Ikom*	*Nkwelle*	*Umudike*	*Jalingo*	*Lafia*	*Kabba*	
Eafro 231 ..	3,231	3,437	2,531	2,383	1,348	1,379	2,450	1,366	1,735	2,207
Eafro 237 ..	2,190	2,151	1,488	2,054	1,281	1,525	2,207	1,429	1,631	1,773
Trinidad ..	2,798	2,962	2,161	2,271	1,302	1,694	—	—	—	2,198
Mexico 5 ..	2,539	3,066	2,154	2,293	1,089	1,428	2,821	1,731	1,962	2,120
ES 1 ..	2,537	2,885	2,163	2,626	1,168	1,646	2,161	1,365	2,043	2,066
ES 2 ..	3,023	3,030	1,929	2,136	1,200	1,307	1,830	1,145	1,567	1,907
Local ..	1,911	2,130	1,396	1,655	1,024	1,137	1,446	682	1,506	1,432
L.S.D. at 5%	606	429	232	348	NS†	NS	341	502	332	—

Yield results of the trials in some of the crop research stations in the three regions (Table 1) and last years results have so far shown the order of yield of performance as follows:

	Eastern Region		*Northern Region*		*Western Region*	
	Variety	% *increase over local*	*Variety*	% *increase over local*	*Variety*	% *increase over local*
Group 1 ..	ES 1 Trinidad	35 32	ES 1 Trinidad Mexico 5	57 55 51	Eafro 231	55
Group 2 ..	Mexico 5 Eafro 231 Eafro 237	23 20 20	Eafro 231 Eafro 237	40 42	ES 1 Trinidad	41 40
Group 3 ..	ES 2	9	ES 2	27	Mexico 5 ES 2	37 32
Group 4 ..	—	—	—	—	Eafro 237	13

The effect of May and June precipitation on yield of maize in the north is shown in Table 2. Increased rainfall in the early months of the growing season (May to June) seems to result in higher yields.

Table 2.—The Effect of May and June Rainfall on Yield of Maize : Northern Nigeria

Location	*Year*	*Yield (lbs/acre)*	*Rainfall (inches) May*	*June*	*Total*
Yandev	1960	1,878	6.6	12.4	19.0
Zonkwa	1960	2,296	4.3	10.4	14.7
Riyom	1960	1,636	5.9	7.4	13.3
Oke Onigbin	1960	1,338	6.1	6.7	12.8
Lafia	1960	993	2.7	5.6	8.3
Keffi	1960	989	4.2	5.8	10.0
Jalingo	1961	2,153	5.7	11.3	17.0
Kabba	1961	1,741	3.1	8.7	11.8
Lafia	1961	1,286	5.7	4.0	9.7
Donga	1961	216	2.4	9.4	11.8

It is believed that yields could be substantially increased in certain areas in the north if planting could be delayed till about the end of June. In that case the plants would receive the full benefit of July, August and September rains which are constantly abundant. Experiments to determine ideal times of planting for the maize growing areas in the north are being proposed.

Late Season Trials.—Late season trials are conducted only in the Western Region where September, October and November rains are sometimes sufficient for successful maize production. With adequate precipitation late maize is capable of producing a good crop ; but in dry seasons as in 1961, the yields fall too low to be of any economic importance.

Yield data of uniform trials performed in eight locations in the Western Region are presented in Table 3.

Table 3.—Late Season Yield Results : 1961 (Lbs/Acre)

Variety	*Ibadan*	*Agege*	*Ilora*	*Ketu*	*Ipokia*	*Ondo*	*Akure*	*Average*
Local	305	784	578	1,580	2,098	235	416	857
Trinidad ..	181	700	889	1,251	2,277	559	431	898
Eafro 237 ..	237	551	475	1,246	1,522	576	215	689
Mexico 5 ..	245	825	634	1,106	1,316	573	353	722
ES 2	—	—	—	1,076	1,648	561	404	—
ES 1	—	—	—	1,012	2,055	571	392	—
Eafro 230 ..	131	331	376	745	1,750	506	286	589
L.S.D. @ 5% ..	NS†	265	NS	232	314	NS	NS	—
Mean Yield ..	220	638	590	1,145	1,809	511	357	—
Rainfall (ins.)*	7.7	13.2	11.8	—	—	10.5	—	—

Poor yields obtained from the 1961 crops were caused by insufficient moisture. The best overall yield was obtained from Trinidad and local varieties. Trinidad is potentially a high yielding variety and the fact that it did best in these trials could be assumed to be largely due to its inherent ability to produce superior yields at all seasons rather than its capacity to tolerate drought. The ability of most local varieties to out-yield the exotic varieties in dry season only, indicates the extent to which the local varieties have been acclimatized.

Table 4.—Mean Yield Versus Available Moisture of Late Season Maize : Ibadan

Year	*Mean Yield*	*Available Rainfall (ins.)*
1959	913	12.7
1960	2,237	16.9
1961	220	10.3

Tables 3 and 4 show that yields were partly determined by the amount of moisture during the growing period. Increased rainfall resulted in increased yields.

* Rainfall during the growing season.

† Yield differences between varieties not significant.

Results of 1961 as well as previous years' trials have demonstrated that none of the varieties so far tried is entirely satisfactory for late season planting, since they perform poorly when the rainfall is very low. In order to ensure consistent and fair returns, attempts are being made to enter in future trials, short and early maturing varieties. Such varieties would need a smaller quantity of water than the varieties now in use and would also be able to mature before the onset of the dry season.

Palatability Tests.—Four maize varieties, namely, Mexico 5, Sicaragua, Lagos White and Eafro 231 were tested on palatability in 1959 by preparing 'eko', a stiff porridge prepared with maize meal, and this test was repeated in 1961. In 1959 food processing was done by the senior students of a local secondary school and in 1961 by the senior girls of a secondary school at Abeokuta. Methods of preparation were similar except that in 1959 the grain was ground on a stone, while in 1961 a milling machine was employed (*see* Memorandum 21). The varieties were ranked in order of acceptability or preference. The ranking order for 1959 and 1961 are shown in Table 5.

Table 5.—Ranking Order of 4 Maize Varieties

Order	1	2	3	4
Ibadan (1959) Students ..	Lagos White	Sicaragua	Eafro 231	Mexico 5
Abeokuta (1961) Teachers	Lagos White	Sicaragua	Eafro 231	Mexico 5
Abeokuta (1961) Students	Eafro 231	Lagos White	Sicaragua	Mexico 5

Statistical analysis indicated that there was a significant measure of agreement between the judges in each experiment. There was a complete agreement between the Abeokuta teachers and the Ibadan students in order of ranking. There was also a degree of agreement between all the judges in ranking Lagos White, Sicaragua and Mexico 5 but the two groups of students differed widely in evaluating Eafro 231. The Abeokuta girls up-graded Eafro 231 because of its hardness and lack of pronounced taste, which were the same reasons given by the Ibadan girls for underrating the variety. Mexico 5 was the least suited for 'eko' in all cases. This was attributed to its lack of flexibility and poor taste. Lagos White was most popular because of its sweet taste and soft texture.

An early release of Eafro 231 to the farmers is anticipated since this variety has proved to be high yielding, particularly in the Western Region.

The Effect of Leafblight of Maize on Yield.—Various levels of Cuman, an organic fungicide based on Ziram, were used in experiments to control the development of various leafblights on maize plants. This should make it feasible to obtain an estimate of reduction of yields due to the more common leafblights. So far, indications are that a depression in yield of 13 per cent occurred during a late season. The effect on an early season crop was approximately 35 per cent. The depression in yield was mainly due to the fungus *Cochliobolus heterostrophus.*

Residues of Endrin Spray in Maize Grain.—In co-operation with the Tropical Products Institute in London a chemical analysis was made of ear samples, harvested from maize plants treated with endrin up to 5 weeks after planting. The T.P.I. determined endrin residues in the grains by the total chlorine method of the solvent extraction of endrin. The results indicated that the endrin content was less than 2 p.p.m.

Key for Assessment of Blight on Leaves of Maize.—Various degrees of susceptibility and resistance to the maize leaf-blight *Cochliobolus heterostrophus* can be recognised by comparison of lesion sizes and the absence of presence of two types of halos around the lesions, a dark one and a light green one. Weekly assessments showed that, on the average, inbred lines of maize are more susceptible to *C. heterostrophus* during the first three weeks after emergence, than later.

Three types of lesions, with a light green halo, without a halo or with a dark grey halo are correlated, in that order, with increasing size of lesion and increasing percentage of leaf area attacked. The various maize plants are to be assessed at equal periods from emergence. Selection based upon the presence of small lesions with a light green halo, should separate the more resistant from the more susceptible maize material.

Production of Cochliobolus Resistant Lines.—Susceptibility tests aimed at production of lines resistant to *Cochliobolus heterostrophus* were carried out in the early and late seasons, 1961. A pure culture of the fungus was maintained and multiplied in the laboratory and used in inoculating the tested plants in the field. 182 inbreds were tested in the early season and 276 in the late season.

The inbreds were developed from West African local varieties, but there were also a few 'Florida' and 'EAFRO' lines. They were inoculated weekly from the third week after planting until tasseling with macerated cultures of *C. heterostrophus.* Those found resistant were selfed and selected for further work.

Routine Disease Assessment.—Leaf blight and rust diseases were assessed in the breeding and trial plots in the early and late seasons in 1961. In the early season incidence of rust was low on many of the imported varieties, including EAFRO 231, Mexico 5×ES 2 and Lagos White×ES 2 crosses.

Leaf blight intensities were also generally low except at Agege in the early season. As the same varieties were tested also in Ibadan and Ilora the susceptible reaction at Agege appears to be due to environmental factors. In Ibadan and Ilora top crosses of Akwete, Ikom and Lagos White with ES 2 indicated a possible combination of resistance against both leaf blight and rust. Mexico 5×ES 2 in trials 61-3-15 (Ibadan) and 61-3-14 (Ilora) also showed resistance to the two diseases.

The second season trials and breeding plots were badly affected by the drought and disease incidence was low.

Maize Introductions.—Seventy-four varieties of maize were added to the collection of maize germplasm held at Moor Plantation:

From Mexico	27
From Northern Nigeria	25
From Mississippi, U.S.A.	12
From Phillipines	4
From Colombo	3
From Western Nigeria	2
From Eastern Nigeria	1

EYF and EWD inbred lines.—A number of EYF yellow flint S 1-inbred lines developed from the varieties Mexico 5 and Sicaragua, which had been selected for their high combining ability, were grown in the breeding plot for multiplication by submating during the early season of 1961. The yields were inadequate for the proposed intercrossing and hybrid production programme. During the late season of the same year, the early onset of the dry season prevented any successful work in the maize breeding plots and therefore this programme will be taken up again during 1962. The EWD-lines of which sufficient seed is available, will be top-crossed with a local floury variety to pursue the production of a synthetic with a more floury nature of the grain.

Breeding for Lodging Resistance in Maize.—The programme involves the use of the tall, rather readily lodging synthetic variety ES 2, and a short-noded, stout-stemmed lodging-resistant, low growing variety, R909. The first selfed backcross material has been obtained, though in very small quantities. It is proposed to continue the backcrossing programme during the next season.

Grain Legumes (Mr F. O. C. Ezedinma)

The work of the grain legume section was reduced to maintaining the collection of the different species under study, following the departure of the Agronomist early in 1961. Some basic studies started by his successor are still in progress and are referred to briefly.

Maintenance of Cowpea (Vigna Sinensis) Collection.—Two hundred and fifty varieties and selections, as well as 115 bulked F6 selections from 10 crosses were multiplied during the early and late 1961 seasons. Observations and laboratory determinations carried out on some of these have been written up elsewhere. Results of quality assessment on ten randomly selected varieties, comprising four Nigerian and six United States varieties showed that the Nigerian varieties rated higher than the United States varieties (Table 1). The investigation will be continued in order to obtain more information along these lines.

TABLE I

SOME QUALITY CHARACTERISTICS AND RATINGS OF TEN COWPEA VARIETIES AT MOOR PLANTATION, IBADAN, 1961

Variety	*Source*	*Seedcoat colour*	*Crude Protein %*	*Oil %*	*Soaking Time (Minutes)*	*Consumers' Preference Rating*	*Probable yield Rating*
Adzuki ..	U.S.A.	Coffee	26.6	1.5	180	Low	Low
Brown Crowder ..	U.S.A.	Brown	27.8	1.4	180	Low	Low
Blackeye .. White .. Crowder ..	U.S.A.	White	26.1	4.0	120	Low	Intermediate
Giant .. Blaceye ..	U.S.A.	White	23.0	1.3	5	High	Low
Honolulu ..	U.S.A.	Black	15.8	1.1	180	Low	Low
Paraguay 12	U.S.A.	Basal colour with black speckles	27.2	2.7	180	Low	Low
Ex Bukuru	Nigeria	White	26.9	1.4	5	High	Low
Dan Malle Wake	Nigeria	White	26.1	1.1	5	High	High
Kano Sabongari	Nigeria	Dark Brown	18.2	1.9	5	High	High
Ex .. Zonkwa E	Nigeria	Dark Brown	18.2	1.0	5	High	High

Development characteristics of Cowpea.—Some of the developmental characteristics of the cowpea were studied in the field. It was observed that when sown at a depth of two to three centimeters, cowpeas emerged within three days. The cotyledons persisted for five days after emergence within which period their food reserves were used up by the seedlings, before they shrivelled and dropped.

The loss of cotyledons concurred with a short-lived lag in growth and dry matter accumulation. Nodulation became evident at the same time but the first foliage leaves opened at seven days after emergence. The opening of the first foliage leaves corresponded roughly with the time when the pink pigmentation of the internal tissue of the nodules was first observed.

Leaf formation and branching are acropetalous in cowpeas. New leaves tend to be produced at fairly regular intervals of four days on each branch. The trailing varieties unlike the bunch and semi-bunch types tended to branch within seven days after emergence. There were no differences in the rates of dry matter

accumulation in relation to growth habit until after 14 days from emergence when the trailing varieties appeared to grow faster vegetatively than the bunch and semi-bunch types. The investigation continues.

Effect of soil pH on nodulation and dry matter yield.—Preliminary results showed that low as well as high pH levels, values of 2-4 and 8-10 respectively, reduced nodulation on cowpeas. Best nodulation was observed at pH 5-6 and on field soil of pH 6.7. At pH 2, the seedlings died immediately after emergence. Very little growth and low dry matter yield were observed at pH 3-4 while the best growth and yield were obtained on field soil of pH 6.7.

The higher pH levels did not appear to affect dry matter yield. These results indicate that cowpeas have an optimum pH range at which they thrive successfully. This investigation was a part of a larger project which was started in co-operation with the Chemist who is now away on study leave. As a result, the investigation had been suspended temporarily.

Influence of cultivation methods on cowpeas.—Studies of the influence of four preparatory cultivation methods on the nodulation and dry matter yields of cowpeas have given some preliminary results. The highest fresh weight of nodules was obtained on deep cultivated flat plots while ridging and moulding up old ridges appeared to reduce the weight of nodules. Dry matter yield was not affected by the different cultivation methods but the incidence of damage to root nodules was recorded most often on surface-cultivated flat plots. This study is being extended to determine the net effect of these observations on the yield of peas.

Fields of up to five per cent slope, cultivated and planted with cowpeas on the flat showed no erosion. This type of cultivation would be preferable to the usual practice of ridging such plots. It may not be necessary to ridge for cowpeas in order to check erosion maximise yields. The investigation continues.

Soyabean (*Glycine maximum*).—Rapid loss of viability under conventional storage conditions was observed in soyabeans during the period and all the varieties failed to germinate after three months storage. The loss of the first few varieties in the collection has been compensated by the introduction of 60 varieties from Mokwa in March 1962. These have been placed in an air-conditioned seedstore where it is hoped that they will retain viability for a longer period than in the open store.

Miscellaneous.—Other species of grain legumes which were multiplied in small plots included lima bean (32 varieties), pigeon pea (4 varieties), bambara groundnut (3 varieties), and *Dolichos lablab* (32 varieties).

Other species collected included green-gram, *Cicer arietinum* and *Kerstingiella geocarpa.*

ECONOMIC COLLECTION

The collections of various economic plants at Moor Plantation are being re-organised to provide better facilities for distribution of the materials to interested parties both within and outside Nigeria. Many of the perennial plants had to be propagated when the site of the economic collection was utilised for building purposes. This material will be planted during the next year on the Northside of Moor Plantation (Field B4).

Seeds of annual crops were kept at ambient temperatures and viability was maintained only for a short period. The viability of the seed often dropped to 50 per cent after six months. The newly harvested seeds will now be kept in a central seedstore at 50°F and 60 per cent relative humidity.

Distribution of Rubber within Nigeria

The following clones were distributed to various locations in Nigeria :—

R.R.I.M. 600	R.R.I.M. 605
R.R.I.M. 601	R.R.I.M. 623
R.R.I.M. 602	R.R.I.M. 628
R.R.I.M. 603	B.R. 2
R.R.I.M. 604	

Plant material Distributed in Nigeria

Amaranthus caudatus	Hibiscus sabdariffa
Cajanus cajan	Paspalum scrobiculatum
Celosia argentea	Solanum melongena (red)
Crotalaria juncea I	Saccharum officinarum
Crotalaria anagyroides	Tephrosia candida
Hibiscus esculentus	Canavalia maritima
Paspalum conjugatum	Calopogonium
Solanum nodiflorum	Corchrus olitorius
Stylosanthes gracilis	Crotalaria intermedia
Sphenostylis stenocarpa	Cucurbita pepo
Arachis hypogea	Mucuna
Capsicum frutescens	Ricinus conmunis
Centrosema	Solanum melongena (white)
Crotaliaria mucronata	Telfairia
Crotalaria lanceolata	

Plant material Distributed outside Nigeria

Pueraria Javanica	Saccharum officinarum

FEDERAL RICE RESEARCH STATION

Development of the Station

The shallow water tanks were completed by sealing them with water proofing compounds. These tanks will be used to study the water requirements of shallow swamp rice under the conditions which obtain at Badeggi. Work was commenced on the construction of a deep water tank. This tank will be used to simulate the rapid rising, deep floods which occur in the naturally inundated lowlands of Nigeria. It will provide a controlled, and easily accessible, environment for the evaluation of new acquisitions for these areas and will be used in the preliminary selection of suitably adapted hybrids from the present breeding programme.

A glasshouse has been constructed at the Station. The design is similar to that developed at the Rubber Research Institute in Malaya. It will be used by the Chemist for pot experiments in plant nutrition studies. A new 'bird cage' has been constructed. This is a wire mesh cage designed to protect valuable new acquisitions and the plants used in the hybridisation programme from the depredations of birds during flowering and the ripening of the grain.

A dark chamber has been constructed ; in this chamber the artificial control of day length is possible and the successful synchronisation of flowering of varieties of different duration has been achieved.

Meteorology

The Station now runs two well equipped meteorological stations, one on the fadama and one on the Station site. In addition to the normal weather recording data, they have evapotranspirometers and are used in conjunction with field experiments and the shallow water tanks to determine the water requirements of rice. The rainfall at Badeggi was well below average in 1961. Apart from isolated storms there was very little rain in April, May and June. This drought was widespread over the Northern Region and greatly reduced the amount of irrigation water available, which setback some of the early planted trials with swamp rice and delayed the planting of Upland Rice. August was also very dry and this second spell of dry weather provided the coup-de-grace for many upland varieties. Rainfall in the latter part of September, October and November was also below average. A summary of the meteorological data recorded at Badeggi is given in Appendix I.

Plant Breeding

Four distinct ecological zones are used for the growing of rice in Nigeria: these are naturally inundated lowlands, the non-inundated irrigable lowlands, the rainfed uplands, and the fresh water mangrove swamps.

It is not possible to obtain a single rice variety with a sufficiently wide range of adaptation to cover all the major zones of rice growing in Nigeria. These zones integrate with one another and in the marginal areas a variety typical of one zone may have a sufficiently wide range of adaptation to be superior to varieties from the neighbouring zone ; but where the ecological conditions are clearly defined it is unlikely that varieties adapted to one environment can compete successfully in another. For this reason the plant improvement programme has been divided and related to individual zones. In 1961 attention was concentrated upon the first three zones. Mr J. E. Y. Hardcastle worked on the breeding programme for the naturally inundated lowlands, Mr J. A. F. M. Sluyters on the programme for the non-inundated irrigable lowlands and Mr B. D. A. Beck on the programme for the rainfed uplands. Mr B. D. A. Beck also worked on the *Oryza glaberrima* varieties and the *O. glaberrima* × *O. sativa* hybridisation programme.

The Naturally Inundated Lowlands (Mr J. E. Y. Hardcastle)

The fadama of the major river systems of the far North of Nigeria are subject to seasonal deep flooding as the rivers rise. They are the traditional areas of cultivation of the indigenous, red grained varieties of *Oryza glaberrima.* In these areas the objects of the breeding programme are the selection of high yielding, white grained floating varieties of *O. sativa* with a flood resistance comparable with that of the indigenous floating varieties of *O. glaberrima.*

Regional Trials.—The evaluation of new floating varieties of *O. sativa* was continued in 1961 in the observation trial at Birnin Kebbi. Seven varieties were compared with a local *O. glaberrima* variety. The trial was subject to floods in excess of 6 feet deep, which was the deepest flood recorded at the experimental site in the last five years. The flood flow was also very marked. There was an abnormally early recession of the flood which caused, in all introductions save

Indo Chine Blanc, a very marked reduction in yield compare with previous years; even the indigenous *O. glaberrima* variety Babban Fari was markedly affected. Only Indo Chine Blanc gave a normal yield; it was earliest maturing of the *O. sativa* varieties in trial and gave a yield equivalent to 1,400 lbs. per acre; in view of its obvious flood resistance and desirable B-type grain it is a very promising variety indeed.

The variety Mali Ong was tested by farmers at Birnin Kebbi in 1960. It proved very popular, and on the basis of its high flood resistance, life period, ease of harvest, high yield and desirable grain type it has been recommended to the Northern Region as an interim variety for distribution. Stage I material was grown at Badeggi in 1961 and it will be included in the Northern Region Multiplication scheme in 1962. It will be distributed in the regularly inundated areas of the Sokoto fadamas. The potential area for rice cultivation is estimated at 90,000 acres and is at present sown with red grained varieties of *O. glaberrima.*

The observation trial of floating varieties at Jere Bowl in Bornu Province was a failure as it was planted too late. The observation trial of floating varieties at Illushi in Benin Province demonstrated that, for most years, an earlier maturing variety than Mali Ong is necessary for this area. Yields were generally uneconomically low and it is not possible to grow two crops in one year.

Inter-variety Trials—Badeggi.—The trial to compare the yields of eight floating varieties of *O. sativa* was continued at Badeggi for a final year. Tisei was again the highest yielding variety in trial. In a joint analysis of four year's data Tisei, Nau Rung and Tau Binh were clearly higher yielding than the remainder. These three varieties produced an average yield over 4 years of 2,000 lbs. per acre, but are unsuitable for introduction to Birnin Kebbi as their life periods are too long to allow them to come to maturity in the flood conditions which obtain there. Also Tisei is a red grained variety. There were no significant differences between the yields of Mali Ong, Mbagboli, Indo China 53 and Champa. Of these varieties, Mali Ong was the earliest and its life period more nearly suited to the duration of the flood at Birnin Kebbi. It produced an average yield over the four years of 1,760 lbs. per acre. Mali Thong produced a significantly lower yield than any other variety in trial. Mali Ong was recommended for the regularly inundated areas of the Sokoto fadama and Nau Rung for irrigated areas liable to occasional deep flooding.

Evaluation of the more recent acquisitions in the variety collection led to the selection of Bhendot T.100 and other floating varieties for field trials. These varieties are of shorter duration than Mali Ong, and they will be grown in observation plots at Birnin Kebbi, Hadejia and Maiduguri in 1962.

Four hundred and ten individual plant selections for earliness were made from the varieties Mali Ong, Indo China 53 and Champa in 1960. Their life periods were compared with those of their parents in 1961 in ear-to-row plots and fifty-seven lines were selected for further trial in 1962. Selections for earliness were also made in other floating varieties for trials in 1962.

Inter-varietal Hybridisation.—The dark chamber has been used successfully to synchronise the flowering of selected floating varieties with shorter duration swamp varieties. The two groups have been crossed together to combine the floating habit and flood resistance of the former with the earliness of the latter.

The dormancy of the hybrid seed of this series of crosses was broken by heat treatment and the F_1 generation is growing well.

Studies on Oryza glaberrima (Mr B. D. A. Beck)

The species *O. glaberrima* is vigorous and well adapted to Nigerian conditions. It has two disadvantages as a culture; the Nigerian varieties are red grained, which limits their consumer appeal and they shatter badly. Seven acquisitions of white grained floating varieties of *O. glaberrima* were obtained from Senegal in 1961 and these were multiplied in 1961 for further trial at Badeggi. All bred true for white grain.

The trial of thirty-one red grained Nigerian varieties of *O. glaberrima* was continued at Badeggi in 1961. The highest yielding variety in trial was Farin Iri which produced a yield equivalent to 3,150 lbs. per acre. There were very highly significant differences between variety yields (P=0.001). There was no significant difference between the yields of Farin Iri, Kyanga Baddande and Tattare. In a combined analysis of the 1959, 1960 and 1961 results there were highly significant differences between varieties and between years (P.=0.001). Jatau and Baddande were the highest yielding varieties. There was no significant difference between the yields of these varieties and Farin Iri and Kyanga. Yields in 1961 were significantly higher than in 1959 and 1960 (P=0.001). The life period of Jatau is too long for it to be used at Birnin Kebbi, but Baddande will be used there in 1962 as a control variety in the observation plots of floating varieties.

Interspecies Hybridisation.—In a programme to combine the vigour of *O. glaberrima* with the desirable grain type and non-shattering habit of *O. sativa*, the two species were successfully crossed in 1958 and 1959. The F_3 and F_2 generations from these series of crosses were grown in the fadama in 1961. In the F_3 generation of the 1958 series of crosses 58 progeny were grown. All bred true for white grain. A high degree of sexual sterility was noted in some progeny. Sterility was measured by the average number of spikelets to set seed in each progeny. There was a close negative correlation between yield and sterility between these progenies. Segregation for earliness clearly occurred within progenies. In the F_2 generation from the 1959 crosses segregation for grain colour was noted. A high degree of sexual sterility was observed in this generation.

The Non-inundated Irrigable Lowlands (Mr J. A. F. M. Sluyters)

The most widely grown variety for these areas is BG79. The main object of the breeding programme is to select a suitable replacement for BG79 with a life period of four months when planted between July and August. Thirty-eight new varieties were added to the shallow swamp collection and the hybridisation programme commenced in 1959 was continued.

There has been a decrease in demand for deep water swamp rices and varieties of long duration. Less attention was paid to these varieties in the period under review and the work was restricted to the evaluation of acquisitions in the Variety-Collection and a yield trial. Several high yielding varieties of between four and eight months duration are now available.

Regional Yield Trials.—The 1960 crop variety trial was repeated only in Southern Zaria in 1961. In this trial BG79 is compared with D114, ADT-20, D52/37, MAS 2401 and Padi Sawah III. In five previous yield trials in this area, BG79 has been the lowest yielding variety and the 1961 results justified the conclusion made in 1960 to replace BG79 by D114. In a series of preference tests D114 was shown not to be inferior to BG79. The determination of the milling quality of D114 was not complete at the time of writing, but present indications are that, when properly handled, it is not inferior to BG79. D114 has been recommended for Southern Zaria and is now included in the multiplication scheme.

Observation plots were planted at five centres in the Northern Region.

At Riyom in Plateau Province in 1960, BG79 was outyielded by Japonica introductions. In 1961, these varieties again outyielded BG79, but the highest yielding varieties were new introductions from Madagascar.

Rojofotsy, one of the most promising of the Madagascar varieties was selected for further trial under local conditions at Hoss in 1962.

In the observation plots at Dass in Bauchi Province the local variety was the highest yielding in 1962. This 'variety' was a mixture of lines and contained 51 per cent BG79. Malioka 823 was the most promising of the new introductions. In Bornu Province the observation plots at Jere Bowl failed because of drought and those at Yau were flooded and drowned. At Daura, in Katsina Province, BG79 was the highest yielding variety. The observation plots at the Tomas irrigation scheme failed through flooding.

At Illushi in the Western Region, MAS 2401 was the highest yielding variety in trial. There was no significant difference between the yields of MAS 2401 and BG79. Both varieties produced a highly significantly greater yield than D99, Lead 35, GEB24/37 and the local variety.

In the Nzerem swamps in the Eastern Region four varieties of 6-7 months duration were compared with BG79. This trial failed as it was planted too late and it was recommended that the trial is repeated.

The variety D52/37 will no longer be included in Regional Trials as a potential BG79 replacement. The milling quality of D52/37 is poorer than that of BG79 as it has a long grain and it has a lower protein content than BG79. The results of analyses carried out by the Tropical Products Institute on hand hulled rice showed D52/37 contained 6.7 per cent protein compared with 9.9 per cent in BG79.

Inter-varietal Yield Trials (*Badeggi*).—The main crop variety trial, in which fourteen 5-month duration varieties were compared with BG79, was repeated for a third year. In a combined analysis of three years data, BG79 was significantly outyielded by MAS 2401 ($P=0.001$) and D52/37 ($P=0.05$). Padi Sawah III, No. 37, Tjina, Patnai and No. 1/18 were consistently high yielding; their yields did not differ significantly from that of BG79. Apart from 1/18 all these varieties have an A-type grain and recommendations on further trials in the Regions will be made when their milling qualities have been assessed. The trial will not be repeated at Badeggi.

The Toma 112 replacement trial, in which 9 varieties of 6-7 months duration were compared with Toma 112, was repeated for a third year. In a combined analysis of three years data, none of the varieties were significantly higher yielding than Toma 112. The most consistently high yielding varieties were Siam 29. Faya and Pokkali. A decision which of these varieties will replace Toma 112 will be made after milling tests, as Toma 112 has a C-type grain and it is desirable to replace it with a variety with a B-type grain. The trial will not be repeated.

In 1961 a new trial to select a high yielding replacement for Kav 12 was commenced. Seven varieties are compared with Kav 12. There was no significant difference between the yields of Khao Bhu Dat and Kav 12. These two varieties produced a significantly greater yield than the other six ($P=0.01$). All the varieties produced yield equivalents greater than 2,000 lbs. per acre. The yield of Khao Bhu Dat was 2,959 lbs. per acre : the life period of this variety is 10 days less than that of Kav 12. The yield of PTB-16 which had performed well in earlier Kav 12 replacement trials was disappointing. The trial will be repeated in 1962.

In 1956, line selection was commenced in the variety MAS 2401. Two of these selections were compared with the parent stock in 1961. The parent stock outyielded both selections ($P=0.001$). The trial will not be repeated.

Intra-species Hybridisation.—The object of this hybridisation programme is to obtain a short (4 months) duration variety to replace BG79. The early varieties MTU-9, Taichu 65 and Precose were crossed in 1959 and 1960 with BG79 to combine earliness with the yielding ability and grain-type of BG79. The three early varieties were also crossed with GEB24/37 to combine earliness with the grain type and palatability of GEB24/37. Of the 1959 crosses (Tai-Chu $65\times$BG79 and MTU-$9\times$BG79) the F_2 generation was grown in the fadama in 1961. The cross MTU-$9\times$BG79 had a shorter life period than that of Tai-Chu $65\times$BG79. F_1 seed from all six 1960 crosses was grown in pots in 1961, the F_2 generation will be grown in the fadama in 1962.

A hybridisation programme to produce varieties of desirable grain type and resistance to lodging under the conditions which obtain in mangrove swamps was commenced in 1958. Line selection was carried out on the F_3 generation at Badeggi in 1961. 271 selections were made from three crosses, and they will be grown at Badeggi in 1962 together with the bulk F_4 generation and the parents. A part of the F_3 seed was sent to the Eastern Region for test under mangrove swamp conditions. One of the crosses lodged badly. Selection of this material was not carried out and it will be grown as bulk F_4 in 1962 in the Eastern Region.

Milling Studies.—Almost all the paddy produced in Nigeria is parboiled before it is brought to the rice mills. As most of the world literature on paddy milling deals with the processing of raw paddy, a study of the factors affecting the milling quality of parboiled paddy was commenced with the object of determining a standard laboratory milling procedure. It was considered that the effects of duration of soaking, the duration of steaming or boiling and methods of drying parboiled paddy required investigation.

A first attempt to study different drying methods was commenced in 1961. It was shown that when parboiled paddy is dried in the sun after soaking for twenty-four hours and boiling for fifteen minutes, the lowest percentage of broken grain was obtained from paddy milled at a moisture content of 16-17 per cent. The results of these tests were submitted for publication in a paper entitled "Parboiled Paddy dried in the Sun ; relationship of moisture content and length of storage to the milling out turn and percentage broken grain".

In a second series of experiments the paddy was dried in the shade. The results were not conclusive and this was partly ascribed to the differences in relative humidity on the different days when drying was carried out. The experiments were carried out from the 4th December, 1961 to 26th January, 1962 and during this period the relative humidity at 9.00 a.m. varied from 21 to 66 per cent and from 14 to 32 per cent at 3.00 a.m. The very low relative humidities occurred during the harmattan. The experiment will be repeated.

Rice Preference Tests.—The Regional Agricultural Officers have regularly requested palatability tests on the new rice varieties recommended for introduction into their areas. A simple test, which is easy to carry out at Regional Centres, has been devised and the earlier method discarded as it was found too difficult to control and the design too complicated.

The new design of preference test has been used at Shendam and Badeggi. Taste tests were carried out with the tasters blind folded and not blind folded, and the "consistent tasters" were not able to distinguish between GEB24/37 and D99. D99 is higher yielding than the GEB24/37 and may be used to replace it. A similar trial at Badeggi, where the tasters were local labourers, showed no significant differences in preference between BG79, D114, MAS 2401 and a local variety.

The Rainfed Uplands (Mr B. D. A. Beck)

The most widely grown upland rice varieties in Nigeria have a C-type glutinous grain. This type of grain is of limited consumer appeal and its popularity is declining. There is a need for a high yielding B-type replacement. The upland varieties currently available are susceptible to attack by *Piricularia oryzae* and *Helminthosporium oryzae* and resistant varieties are urgently required. The main objects of the breeding programme on upland rice are to produce a high yielding variety with a B-type grain and resistance to *Piricularia* and *Helminthosporium.*

Regional Trials.—The series of Regional Trials to select a high yielding replacement for the glutinous variety Agbede was continued in the Western Region in 1961. Two Agbede selections were compared with three Nigerian upland varieties and an upland variety from the Cameroons. The yields are summarised in Appendix 2. The two short duration shallow swamp varieties Precose and MTU-9 included in these trials in 1960 were discarded. These varieties were found to be highly susceptible to *Piricularia and Helminthosporium* when grown under upland conditions.

At Obior, the Nigerian variety Jete was the highest yielding variety in trial ; it produced a yield equivalent to 1,100 lbs. per acre. There were no significant differences between the yields of the six varieites. At Irrua, as in 1960, Jete was the highest yielding variety, producing a yield equivalent to 1,600 lbs. per acre.

There was no significant difference between the yield of Jete and Kogbandi ; Jete produced a significantly higher yield than any other variety in trial (P=0.01). At Ofada, Jete was the highest yielding variety in trial, producing a yield equivalent to 1,400 lbs. per acre. There were no significant differences between variety yields in this trial. As in 1960, the highest yields of upland rice were recorded at Ijebu Ode. Jete was again the highest yielding variety in trial producing a yield equivalent to 2,970 lbs. per acre. The yield of Jete was not significantly greater than that of Kogbandi, but was significantly greater than any other variety in the trial (P=0.05). At Ipokia, Jete produced a yield equivalent to 1,920 lbs. per acre, there was no significant difference between the yields of Jete and Oshodi. Jete produced a significantly greater yield than any other variety in trial (P=0.05). At Erin Oke, Jete produced a yield equivalent to 2,270 lbs. per acre, which was significantly greater than any other variety in this trial (P=0.01). At Ikole, in 1960, Kogbandi and Jete were the highest yielding varieties, but in 1961 they failed and in a low yielding trial Bikom was the highest yielding variety with a yield equivalent to 1,490 lbs. per acre and significantly outyielded Jete (P=0.05) and Kogbandi (P=0.001). Bikom was also the highest yielding variety in trial at Alade. There was no significant difference between the yields of Bikom and Jete. Kogbandi failed badly in this trial producing a yield equivalent to only 18 lbs. per acre.

In a joint analysis of this series of trials, the error variances of the eight trials were shown to be homogeneous by Bartlett's test. Over the series of trials, Jete was the highest yielding variety but differences between varieties just failed to be significant. Jete produced a mean yield of 1,780 lbs. per acre, 300 lbs. per acre more than its nearest rival Agbede 140/54. Variety yields varied markedly between Stations and the Variety × Station interaction was highly significant (P=0.001). There were highly significant differences between Stations, the highest average yields occurred at Ijebu and were significantly greater than those obtained at all other Stations. The lowest average yields were obtained at Obior.

The C-type Agbede selection, No. 140/54, was slightly higher yielding than the B-type selection No. 16/56. It outyielded Agbede 16/56 at Ofada, Ijebu, Erin Oke, Ikole and Alade. The difference was only large enough to be significant at Erin Oke and Alade. At Obior, Irrua and Ipokia Agbede 16/56 produced a higher yield than Agbede 140/54 but in none of these trials were the differences large enough to be significant. At Irrua, the 1960 trial was repeated to compare the yields of four new upland varieties with the two Agbede selections. In 1960, Suduwee, an introduction from Ceylon, was the highest yielding variety (P=0.01). In 1961 there was no significant difference between the yield of Suduwee and that of Agbede 16/56 which was the highest yielding variety in trial. Yields in this experiment were low in both 1960 and 1961 ; Agbede 16/56 produced only 900 lbs. per acre in 1961. It is considered that three of the new introductions, two from Ceylon and Nigeria selection, have a greater yield potential than some of the varieties currently in trial in the Western Region. Therefore Kogbandi, Bikom and Oshodi have been discarded from the 1962 trials and replaced by Suduwee and VI.28061 from Ceylon and Alabere B, a Nigerian selection. Jete is retained for further trial in 1962. Under the wet conditions this variety is markedly awned and preference tests will be carried out in the Western Region before it is considered as a possible Agbede replacement. All these varieties are of rather too long duration to be suitable for the drier areas of the Northern Region and no new trials were carried out in the North in 1961.

Varieties were tested in a variety collection established on an upland site at Station in 1961. The late onset of the rains delayed planting until July and the dry spell in August proved too severe for most of the varieties. Establishment was generally good but some varieties died within the first two months. All varieties whose life period (to 50 per cent flowing) was greater than 115 days failed to produce a crop and the highest yielding varieties had a life period of less than 100 days when planted on 7-7-61. All the *Oryza glaberrima* varieties proved extremely photo period sensitive and flowered in less than 110 days. Mai Kaya, a Nigerian variety of *O. glaberrima* was the highest yielding variety in the collection. The 1961 collection was replicated on the fadama and there was a high negative correlation between the yields of the two collections, indicating the degree of physiological specialisation in these varieties.

The incidence of fungus diseases on rice grown on the upland site at Badeggi was very high. *Piricularia oryzae*, *Helminthosporium oryzae* and *Curvularia lunata* were isolated from infected leaves. The fungus diseases were markedly more severe on the collection when grown on the upland site than when grown on the fadama. Several varieties in the upland collection were killed by *Piricularia* and in the 'blast' stage this disease was easy to identify. Considerable difficulty was experienced in distinguishing in the field between the leaf symptoms of *Piricularia, Helminthosporium* and *Curvularia*. The incidence of these diseases is known to be high at Shendam and in 1961 disease assay plots were established there to screen varieties for disease resistance. The same difficulties of disease identification were experienced at Shendam. Identification from herbarium specimens of infected rice plants either directly or by single lesion cultures is relatively easy, but very time-consuming and a full examination of the 1961 material was not complete at the time of writing. A collection of putative *Piricularia* resistant lines was imported in 1961. In 1962, the disease assay plots will be established on the upland site at Badeggi in co-operation with the F.A.O. 'Blast Nursery trials' and they will be laid out according to F.A.O's. design.

An upland variety yield trial containing 16 promising acquisitions was planted at Badeggi. This trial failed due to drought and clearly most of the varieties were of too long duration for this area. Two experiments to investigate methods of growing Agbede multiplication plots in the Bida area were planted at Badeggi. The first was to determine the optimum seed rate for Agbede 16/56 when sown from a seed drill and the second to determine the optimum seed rate and spacing for Agbede when direct seeded. Both experiments failed in the drought and will not be repeated.

Agronomy (Mr Th. Bredero)

Plant Population Studies

The standard spacing for transplanted rice at the Rice Research Station is 9 inches by 9 inches. This spacing was found to be the optimum for conditions at Badeggi in trials conducted in 1958 and 1959. Yield increased with decreasing spacing, and at 9 inches by 9 inches the increase in yield more than compensated yield losses which occurred due to increased lodging at the closer spacings. The effect of number of plants per stand on yield was also investigated in the 1958 and 1959 trials but no significant differences were recorded. To investigate this further in 1961, a trial was planted to compare the yields obtained when the

number of plants per stand varied from 1 to 15. Three varieties of low, medium and high tillering capacity were used. A preliminary analysis indicates that the yields obtained from 2 and 8 plants per stand were significantly greater than for other stand numbers. It is interesting to note that the variety of low tillering capacity, Tai Chu, significantly outyielded BG79, a variety of medium tillering capacity, with 3 plants per stand. Tjina, the high tillering variety, produced a significantly greater yield than Tai Chu with 5 plants per stand. The trial will be repeated in 1962.

The effect of spacing on yield is, in part, a measure of plant competition in the field for radiant energy, nutrients and other environmental factors. Spacing can conveniently be expressed as the unit area occupied by a single plant and a given area may be varied in shape. The study of the yield response to variation in the size and shape of a given plant area were studied at Badeggi in 1959, 1960 and 1961. Three varieties which differed markedly in tillering capacity, No. 37 of low tillering capacity, BG79 of medium tillering capacity and Tjina of high tillering capacity were used with 3 unit areas, 36, 64 and 144 square inches per plant. The shapes of the areas were square, sides in the ratio 2 : 2 and oblong with sides in the ratio of 1 : 4. In 1960 there were significant differences in yield between all spacings ; maximum yield was obtained at 36 square inches per plant and the minimum yield from 144 square inches per plant. In 1961 the same trends were found, but significant differences could not be demonstrated in this trial because of a high experimental error. In a combined analysis of three years results, a significantly greater yield per acre (22 per cent) was obtained from plants with 36 square inches per plant than from plants with 144 square inches per plant. The shape of the area per plant had no significant effect on yield at 36 square inches per plant, but with the larger areas the area shape was critical. Square areas with side lengths in the ratio 2 : 2 gave a significantly greater yield than oblong areas with side lengths in the ratio of 1 : 4. There were no significant interactions between area and shape. The high tillering variety Tjina significantly outyielded No. 37 and BG79.

Uniformity Trials with Swamp Rice

In 1957, 1959 and 1960 uniformity trials were planted at Badeggi using the standard spacing then in use of 12 inches by 12 inches. The smallest unit studied was 1/250 acre or 144 plants. The results of these trials indicated that the optimum plot size for trials at Badeggi with transplanted swamp rice was between 1/42-1/125 acre with 6 to 10 replications. It was considered that these trials should be repeated using the new spacing of 9 inches by 9 inches with three plants per stand. The smallest unit for study in these trials in 1961 was 49 plants. The analysis of data from this trial was not complete at the time of writing and will be published later.

Nursery Technique

Data from a nursery technique trial carried out in 1958, 1959 and 1960 was analysed in 1961. The objects of the trial were to determine the optimum combination of cultural techniques in the nursery to produce the maximum yield in transplanted swamp rice. The following treatments were tested in all combinations, method of sowing (broadcasting vs. drilling), seed rate (300 vs. 600 lbs. per acre), time in the nursery (4 vs. 8 weeks) and fertilizer treatment. (1.3 cwts per acre of sulphate of ammonia vs. no fertilizer). The seedlings were transplanted under uniform cultural conditions in the field and the effect of nursery

treatment measured by yield at harvest. Only in 'time in the nursery' treatment were there any significant differences. In 1958 and 1960, plants grown for 4 weeks in the nursery gave a significantly greater yield than plants grown for 8 weeks, but in 1959 this effect was reversed. (In 1959 the nursery was seeded 6 weeks later than in 1958 and 1960). A new experiment has been designed for 1962 to compare 3 sowing dates at 8 week intervals, three periods in the nursery and three levels of application of ammonium sulphate.

Tractor Cultivation

The standard practice for preparation of the land for transplanting swamp rice at the Rice Research Station is to cultivate the land when flooded with a Howard rotavator drawn by a Ferguson tractor equipped with half tracks. This produces an admirable medium for transplanting, but rotavation is only a very shallow cultivation and, it is feared, will not control the indigenous, deep rooted perennial weeds on the fadama. To study the effect of mechanical cultivation on the occurrence and composition of the weed flora of the fadama soils, an observation trial to compare five methods of cultivation was commenced in 1961. A continuous fallow was used as control, and compared with (*a*) rotavation before planting, the present practice; (*b*) deep ploughing after harvest every year, to expose the rhizomes of perennial weeds during the dry season followed by rotavation before planting; (*c*) and (*d*) deep ploughing after harvest once every two years, and once every three years with rotavation every year before planting; (*e*) deep ploughing after harvest followed by disc harrowing in the dry before irrigation and transplanting. The composition of the weed flora will be determined each year before the irrigation and cultivation and after harvest by the rank frequency method.

Seed Dressings on Broadcast Swamp Rice

The trial to compare the effects of Fernasan A, Fernasan D and Dieldrex B on the yield and germination of broadcast swamp rice was not repeated in 1961. In 1959 and 1960 the yield responses had consistently been in order of magnitude Dieldrex B > Fernasan D > Fernasan A > Control. Significant responses could not be demonstrated because of difficulties of water control on the experimental site, and the trial will be repeated in 1962 at Badeggi and in Jere Bowl on sites with better water control.

Regional Trials

The data from the 1961 spacing and plant population trial with transplanted shallow swamp rice at the Tomas Irrigation Scheme, and the spacing and plant population trials with direct seeded swamp rice at Shendam had not been analysed at the time of writing. The Shendam trial was replicated in Jere Bowl but this trial failed through flooding. All three trials will be repeated in 1963.

Crop Rotation Experiments

A programme of investigations has been commenced to select legumes able to grow in fadama soils during the dry season without supplementary irrigation. The leguminous crop may be used as a green manure, a cattle food and/or a source of legume grain for human consumption. A collection of legumes was screened in observation plots in the dry season of 1960 and selected species were put into randomised block trial on the fadama in the beginning of the dry

season in 1961. The selected legumes were *Stylosanthes gracilis, Crotalaria juncea, Crotalaria retusa, Dolichoslab lab, Centrosema pubescens, Sesbania macrocarpa, Calapogonium mucunoides and Desmodium puris.* The plots were split for the application of superphosphate to compare applications of 0 and 1 cwt per acre. Growth was disappointing compared with the observation plots of the previous year, probably because the fadama water table was much lower in 1961 due to the abnormally low rainfall in the wet season. With the onset of the rains in 1962, growth has improved and striking differences are now visible between the superphosphate and untreated sub-plots. The green material will be cut and ploughed-in in July 1962 and rice planted as a test crop. The experiment will be repeated in 1963 with regular soil sampling and determinations of total nitrogen, ammonium and nitrate ions. Observations on a number of other grasses and legumes are being continued and new introductions added to the collection.

Cattle Cultivation

To investigate the possibility of developing a mixed farming system with rice, two Zebu bullocks have been trained to work in wet conditions on the fadama. Cattle-drawn implements, ploughs, harrows and puddlers are being tested on the fadama soils. The cattle are at present maintained through the dry season on Gamba grass hay and maize sileage grown on the upland site, but it is hoped in the future to grow their fodder on the fadama during the dry season.

Fertilizer trials with Swamp Rice

Fertilizer trials on swamp rice have been carried out for the last five years on the major soil series of the alluvial flood plain of the Kaduna river at the Edozighi Irrigation Scheme. The soil series have been identified as representative of the larger soil groups of the Niger river flood plains. The results from these experiments can therefore be considered applicable to the development of rice fertilizer practices in this area.

EA4(58)61 was originally laid out on three soil series at Edozighi ; the Edozighi, Gbagigi and Mawogi series. In 1958, the treatments consisted of applications in all possible combinations of ammonium sulphate and superphosphate at 0.3 and 6 cwts per acre. In 1959, 1960 and 1961 the plots were split and muriate of potash was applied at 0 and 1.5 cwts per acre. The Edozighi series is a heavy peaty clay containing 16 per cent organic matter with an impervious clay subsoil. The experiment site was cleared from 'Kurmi' for rice cultivation in 1958. Since the beginning of the experiment increasing responses to nitrogen and phosphorus have been observed, indicating a gradual depletion of the initially very high fertility level. In 1961, insufficient water was available immediately after transplanting and this adversely affected the growth of the rice. Yields were still very good, control plots giving a yield equivalent to 2,860 lbs. per acre, but the coefficient of variation (27 per cent) was too high to demonstrate significant differences between treatments. The experiment will be repeated in 1962 and the Chemist will take regular samples for leaf analysis throughout the growing season.

The Gbagigi soils series is a very clayey sand, typical of only a relatively small area of the flood plain. The experimental site on this series was abandoned in 1960 because of difficulties in water control. Significant differences between treatments were obtained in 1958 and 1959 and a yield increase of 60 per cent from applications of 3 cwts per acre of ammonium sulphate recorded.

The Mawogi soil series is a brownish grey sand up to about 6 inches, passing into a grey, sandy clay and is representative of the higher levee soils. In the trial on the Mawogi series in 1961, application of 3 cwts per acre of ammonium sulphate produced a yield increase of 27 per cent. Water control on this trial was satisfactory and the coefficient of variation was very low (6.6 per cent). The trial produced a yield of 1,052 lbs. per acre emphasising again the low yield potential of these soils. Although significant responses to sulphate of ammonia were also obtained in 1959 and 1960 it is doubtful if the yield increase is economic at the present level of prices of rice and fertilizers. The trial will be continued in 1962.

Experiment EA12(56)61 is sited on the Badeggi soil series. The Badeggi series is grey, sandy clay whose clay content increases with depth and is representative of the basin soils in the main flood plains. In this experiment, applications of ammonium sulphate and superphosphate at 0.2 and 4 cwts per acre compared in all combinations in 1956-1958. In 1959-1961 the plots were split for muriate of potash allied at 0 and 1.5 cwts per acre. Past results shew consistent yield responses to ammonium sulphate applied at 2 and 4 cwts per acre. In 1961, highly significant increases of 51 per cent and 86 per cent were obtained with these rate applications. The yield of the control plots was equivalent to 1,520 lbs. per acre. Fertilizer responses are likely to be economic on this soil series. Soil, straw and grain samples were collected in 1961 from all treatments to study the efficiency of nutrient uptake in the different rates of application. The experiment will be repeated in 1962 and leaf samples will be collected by the Chemist.

The low rainfall in 1961 and the consequent shortage of irrigation water considerably depressed yields compared with 1960 when the rainfall was adequate. It is hoped to summarise and publish the results of these trials in 1963, together with data from soil and plant analysis.

Water requirements

To determine the water requirement of shallow swamp rice four shallow water tanks have been constructed. They are being sown at differing seed rates to follow the changes in water consumption of varying plant populations of rainfed rice. Pot experiments to study the influence of soil moisture tension on the growth rate, transpiration rate and yield of rice have been designed. A field experiment to determine differences in water consumption of rice at different seed rates and spacings has been planted. It is intended to attempt to apply Penman's "heat budget theory" to the treatments of this experiment. To this end, observations on the ground water table, soil moisture, root development, growth rate and development of leaf cover, soil temperatures, potential evapo-transpiration rates, rainfall, windspeed, maximum and minimum temperatures and wet and dry bulb thermometer readings will be recorded on or near the experimental area. The equipment for this work was obtained and calibrated in 1961.

Herbicides and Weed Control Studies (Mr A. Vaillant)

A study was made of local cultural practices in the rice fadamas around Bida. It was observed that after harvest the weeds and stubble were burnt, and the top soil turned with a hoe. The land was frequently made into heaps in December and planted with either cassava in January or with groundnuts in April. Both these crops are harvested in June or July and the heaps spread in preparation for

the rice crop. This practice almost completely eliminates the perennial rice *Oryza Barthii* which is a serious weed of cultivated rice. It does not control the *Cyperus* species, and *Imperata cylindrica,* both of which are perennials, or the annual weed species. These need to be destroyed either by further cultivation or by chemical treatment. An experiment to investigate the control of weeds with pre- and post-emergence treatment with MCPA and ATA (Amicol) has been designed for the Edozighi area on a site where there is a wide range of weed species. A trial to compare the efficiency of the commercial herbicides ATA, MCPA PCP and Stam F.34 with hand cultivation has commenced at Badeggi and the results will be published later.

Soil Chemistry (Mr J. Takahashi)

In 1958 a series of fertilizer trials were commenced at Edozighi to determine the optimum rate of application of nitrogen, phosphorus and potassium fertilizers for the soils of the Kaduna and Niger flood plains. The trials were very precise and significant yield increases were demonstrated from applications of nitrogen and phosphorus. The trials will be continued in 1962 to permit the Chemist to carry out complementary soil and plant analysis to study the efficiency of uptake of the major elements.

In preliminary studies of soil samples from these trials in 1961, striking differences between the levels of nutrients available from the different soil types were noted. The fertilizer trials were carried out on three different soil types: (*a*) Kurmi soil of the Edozighi soil series, which is a heavy, peaty clay containing 16 per cent organic matter, and was cleared for cultivation in 1958 : (*b*) two river band deposit soil series, the Badeggi series, a grey sandy soil whose clay content increases with depth ; and (*c*) the Mawogi series, a brownish, grey sandy-clay-soil with a compact almost impervious fine sandy-silt-clay layer occurring usually about 20 inches below the surface.

The Kurmi soil contained more than twice the mineralisable nitrogen and five times the available phosphorus of the river band soils. At none of the experimental sites did heavy applications of nitrogen (4 and 6 cwts of ammonium sulphate per acre) cause large increases in available nitrogen. The detailed data from these analyses is given in Appendix 3. The power of the Kurmi soil to supply nitrogen is remarkable and is calculated to be equivalent to an application of 6 cwts of ammonium sulphate per acre. This explains in part the high yields of rice obtained from the 'no fertilizer' plots in this experiment, although this soil has other commendable characters also.

Unlike nitrogen, available phosphorus very clearly reflects the treatments. According to Bray and Kurtz's accepted levels of nutrient status, on the plots of the river band soils where phosphorus has not been applied during four years of cropping, the soil is now on the verge of phosphorus deficiency. Successive applications of superphosphate have almost trebled the available phosphates in these soils and have built up an almost adequate phosphorus status. The phosphorus supplying power of the Kurmi soil is remarkable even after four years of cropping without application of superphosphate. Superphosphate treatments have resulted in a still higher phosphorus status being attained.

It was found that the cation exchange capacity and exchangeable cations are very low in the river band soils. On one of these soils, the Mawogi series, symptoms of a physiological disorder described as 'leaf bronzing' occur. It was suggested by the Plant Physiologist to be attributable to calcium deficiency and the present soil analysis data tend to confirm this. Preliminary data from the analysis of samples of rice straw collected from this experiment in 1961 show that the calcium content of the straw was very low, averaging around 0.05 per cent.

Studies were made on the changes in soil pH and oxidation reduction potential with time after submergence. The changes in pH are given in Appendix 4. In all examples studied, the pH increased with time over the first 13 days after submergence; during this period the oxidation-reduction potential of all the soils decreased very markedly indicating the activity of aerobic bacteria. In the later stages of submergence, the oxidation-reduction potential decreased more slowly with the commencement of activity by anaerobic bacteria. The Kurmi soil has a high rate of conversion of organic nitrogen to the ammoniacal state which can be taken as a measure of the high microbial activity under submerged conditions. However, the Eh values of soil do not become so low as to be critical to the good development of the rice root; it is considered that this critical level is around—200 mV. This soil may be described as "well poised" and contains a considerable quantity of iron. The river band soils are poorly poised because the Eh values are lower than those of the Kurmi soils in spite of the fact that release of ammonia is extremely low. The oxidation—reduction potential of the soils receiving heavy dressings of ammonium sulphate and superphosphate are lower than the untreated soils and this is considered to be due to the richer supply available phosphorus which is beneficial to microbial activity.

APPENDIX I

METEOROLOGICAL DATA FOR FEDERAL RICE RESEARCH STATION, BADEGGI, 1-4-61 TO 31-3-62

Month	*Rainfall (in) Badeggi*	*Average Rainfall (in) Bida 30 Years Av.*	*Mean Relative Humidity % 0900 GMT*	*Max. Temp.*	*Min. Temp.*	*Mean Temp.*
April	1.92	2.94	67.4	97.0	76.0	86.5
May	1.66	5.94	68.5	94.0	76.0	85.0
June	3.52	7.28	73.9	90.0	74.0	82.0
July	11.90	8.12	85.0	85.0	73.5	79.3
August	3.61	8.20	78.3	85.4	72.9	79.2
September	8.61	10.10	82.1	86.3	72.8	79.5
October	2.55	4.63	75.8	91.1	73.0	82.0
November	0.00	0.30	57.6	94.3	66.3	80.3
December	0.00	0.00	43.1	93.4	57.2	75.3
January	0.00	0.12	32.7	94.0	56.5	75.3
February	0.00	0.30	36.6	97.8	63.6	80.7
March	0.38	1.10	60.0	98.9	75.6	87.2
TOTAL	34.15	48.76				

APPENDIX II

THE YIELD OF SIX UPLAND RICE VARIETIES AT EIGHT CENTRES IN THE WESTERN REGION IN 1961

(*Yields in Pounds Paddy per Acre*)

	Obior	*Irrua*	*Ofada*	*Ijebu*	*Ipokia*	*Erin Oke*	*Ikole*	*Alade*	*Mean yield per acre*
Jete	1,108	1,855	1,387	2,973	1,915	2,273	959	1,771	1,780
Agbede 140/54	1,019	1,196	1,311	2,149	1,549	1,821	1,221	1,541	1,476
Agbede 16/56	1,025	1,447	1,131	1,821	1,619	1,161	1,160	1,020	1,298
Oshodi	987	1,386	1,229	1,754	1,723	1,766	1,265	1,213	1,388
Bikom	587	1,165	1,014	1,667	1,589	1,706	1,486	1,890	1,388
Kogbandi	974	1,652	1,113	2,672	1,444	1,769	684	180	1,308

APPENDIX III

THE NUTRIENT STATUS OF SOILS FROM FERTILIZER TRIALS IN THE KADUNA FLOOD PLAIN

Expt. Sites	*Treatment*	*Mineralizable Nitrogen (mg N/ 100 g oven dry soil)*	*Available P (ppm)*	*C.E.C. (meq 100 g)*	*K*	*Exchangeable Cations (meq/100 oven dry soil)* *Ca*	*Mg*	*Na*
River band Soil : Badeggi Series ..	No fertilizer ..	7.18	7.34	9.98	0.137	2.55	0.421	0.148
	Heavy NP dressing	7.16	21.04	9.41	0.128	2.41	0.436	0.141
River band Soil : Mawogi Series ..	No fertilizer ..	3.74	8.36	3.75	0.049	0.98	0.106	0.103
	Heavy NP dressing	3.15	21.70	2.48	0.050	0.81	0.115	0.099
Kurmi .. Edozighi Series ..	No fertilizer ..	14.45	44.26	25.4	0.746	8.65	1.322	0.223
	Heavy NP dressing	16.74	66.62	32.0	1.164	8.63	0.982	0.216

Remarks : 1. Mineralizable nitrogen was measured by extracting NH_4-N with 10% NaCl Solution of pH 2.5 after incubating the soil at 31 C under submergence for 4 weeks.

2. Available P by method contained in R. Spencer's Memorandum No. 30.

3. C.E.C. by Shollenberger's method.

THE TREND OF THE pH CHANGE IN SOILS FROM THE KADUNA FLOOD PLAIN WITH TIME AFTER SUBMERGENCE

Expt. Site	*Treatment*		*After submergence*				
			1 *day*	5 *days*	13 *days*	18 *days*	25 *days*
River band Soil : Badeggi Series	No fertilizer	Eh mV	430	0	−130	−80	−110
		pH	4.7	5.8	6.4	6.4	6.2
	Heavy NP dressing	Eh mV	420	−50	−165	−150	−90
		pH	4.75	6.35	6.4	6.4	6.6
River band Soil : Mawogi Series	No fertilizer	Eh mV	440	−20	−110	−100	−120
		pH	4.75	5.95	5.7	5.4	5.5
	Heavy NP dressing	Eh mV	390	−60	−90	−100	−80
		pH	4.9	6.2	6.4	6.3	6.2
Kurmi : Edozighi Series	No fertilizer	Eh mV	405	10	−40	−50	−30
		pH	5.2	5.8	5.8	5.8	5.8
	Heavy NP dressing	Eh mV	370	−40	−40	−50	0
		pH	5.1	5.5	5.8	5.8	5.8

FEDERAL ROOT CROP RESEARCH UNIT

Development of the Station

The Root Crop Team of the Federal Department of Agricultural Research has nearly completed the transfer of its headquarters from Ibadan to the Regional Research Station at Umudike.

At present the team is housed in the laboratory built for the Soil Fertility Unit of the Federal Department. Further laboratory facilities are planned and may be available within two years.

The present staff of the team is:—

2 Plant Breeders.

1 Technical Officer.

11 Field Staff:

- 1 Assistant Technical Officer.
- 1 Senior Agricultural Assistant.
- 4 Agricultural Assistants.
- 5 Field Overseers.

1 Clerk, Grade III.

1 Clerical Assistant.

Six of the Field Staff are housed in quarters which were completed in January 1962. It is proposed to build further quarters in the forthcoming year. The problem of Senior Staff housing is serious; various delays have caused an interruption to the building programme. One member of staff is accommodated in regional quarters and the other is at present working in facilities at W.A.I.F.O.R., Benin.

Programmes

It has been necessary in light of the present staff shortage and past work, to review the programmes of work on root crops and in particular the programme for cassava. Although much is known about the hybrids produced by the Department, very little is known of the potential qualities of the numerous local varieties. By an assessment of local cassava varieties it is hoped to produce, in a relatively short space of time, high yielding varieties suitable for particular areas. The revision of the programme will also permit the work on cassava to be brought in line with the work being carried out on other root crops.

The programme has been divided into a Short Term Project and a Long Term Project. Although these projects will be described separately they will be put into operation together.

Short Term Project

The Short Term Project is to last five years. The aim of the project is to produce high yielding varieties suitable for particular ecological areas and suitable to the preference of the local consumer. The field resistance of the varieties to Cassava Mosaic Virus will be of secondary importance. The cassava-growing area in Nigeria has been divided into an area north of Minna, where the consumer preference is for 'sweet' cassava and not gari production, and the area south of Minna. It has been decided that Samaru should be the centre of collection and for trials for the Northern Area. The collection at Samaru will be duplicated at Umudike. An assay will be made on the prussic acid content of these northern varieties.

The area south of Minna has been divided into suitable ecological and administrative zones (Table I). The administrative aspects are important as regards posting Federal Staff to the zones and for shorter lines of communication.

TABLE I

Zone	*Centre*	*Trial Stations*
Middle-Belt ..	Mokwa	Badeggi, Osara, Ilorin, Yandev.
South-West ..	Ibadan	Ilora, Agege, Akure.
Mid-West	Benin	Effurun, Agbor, Akure.
East	Umudike	Abak, Abakaliki, Nekede (Owerri).

In the first year, collection of as many local varieties as possible will be made at each trial station. The collection will be duplicated at the zone centre and at Umudike. The varieties will be multiplied, and it is thought that during this period some indication will be shown of their potential.

During the 2nd and 3rd years the collections will be placed into variety yield trials. From these trials the variety or varieties best suited for a particular area will be selected as the yardstick for the hybridisation programme. The collections at each trial station will be transferred amongst the other trial stations within its zone. It will be possible at this stage to feed into this programme the hybrids at present under test.

The 4th and 5th years of the programme will consist of expansion, more hybrids will be placed under trial against the local standards and the collections at zone centres will be passed between each other.

It is thought that this programme will consolidate the work which has been done and also yield vital and very necessary information on the variation to be found amongst Nigerian varieties.

At each zone centre there will be multiplication plots of the recommended varieties for the zone and these plots will provide material for the Regional Departments to continue more detailed work.

Long Term Project

Until the evaluation of the many hybrids has been made, no further large series of cross-pollinations will be attempted except for a few selected crosses where additional information is required.

Plots of selected clones will be laid down and open-crossing permitted. Once this work has been completed, the objects of the project can be implemented:

1. Breeding for resistance to Cassava Mosaic Virus.
2. Breeding for (*a*) high yield.
   (*b*) high starch content.
   (*c*) high dry matter content.
   (*d*) low cyanide content.
3. National Collection.
4. A study of the genetics of the genus *Manihot.*

The material for this work will come from the

(*a*) introduced varieties from Amani, Bermuda, etc.

(*b*) selections from local varieties.

(*c*) improved hybrids.

(*d*) related species of *Manihot.*

Cassava

The collection of cassava varieties has been extended by the acquisition of the 1957-58 hybrids, introduced and Nigerian local varieties. Both cuttings and seeds have been received from Ghana and cuttings have been received from Malagasy. The cuttings are being grown under Plant Quarantine conditions at Moor Plantation. A collection of 317 local varieties from Eastern Nigeria has been acquired from the Eastern Region Ministry of Agriculture.

Forty-one varieties which were collected from the Northern Provinces of the Northern Region and planted at Samaru have been duplicated at Umudike to investigate the influence of different soil and climatic conditions on the content of hydrocyanic acid in the roots of these so-called 'sweet' varieties.

Seven varieties which were acquired from Yola in 1959 were planted at Moor Plantation in 1960 in a randomised block design with four replications using variety 53101 as a control. The trial was harvested after twelve months growth. Variety 53101 gave a significantly higher yield than any other variety in the trial.

Regional Trials

The variety trials at Agege, Ilora, Ilorin, Mokwa, Akure and Osara were harvested and repeated including new selections from the selection centres. Variety trials were also planted at Abak, Nekede, Abakaliki and Umudike in the Eastern Region, at Badeggi in the Northern Region and at Effurun in the Western Region. Besides, thirteen varieties were planted at Jalingo in observation plots. The highest yielding varieties will be included in future variety trials.

At Ilora, Ilorin, Mokwa and Akure the control variety, 53101, gave a very significantly higher yield than the local variety ($P=0.001$), except at Ilora ($P=0.01$). At Akure 53101 gave a significantly higher yield than any other variety under trial. At Ilora, Ilorin, Mokwa and Osara 53101 gave a higher yield than any other variety in trial except for 58382 at Ilorin and Osara. At Agege there was no variety which gave a higher yield than the local, 58382. Here the local variety gave a significantly higher yield than a control variety 43083, 57174 ($P=0.001$) and 59394 ($P=0.01$). At Mokwa and Osara the local variety gave a significantly higher yield than 43083. Variety 43083 gave a higher yield than the local variety at Ilora, Ilorin and Akure but only at Ilora was the difference in yield large enough to be significant ($P=0.05$).

The variety trial at Yandev had to be written off due to very poor germination. The planting materials were stored too long and were subsequently dried out before they were planted. The trial has been repeated.

Germination of this year's series of variety trials has been good. The mean germination percentage of all trials but four was over 90 per cent. At Ilora, Abak and Abakaliki the mean germination percentage varied between 80 and 90 per cent. The mean germination percentage of the trial at Ilorin was only 63 per cent which was probably caused by a prolonged drought.

Trials at the Selection Centres

The twenty highest-yielding selections from the 1956-57 series of pollinations which were planted at the West African Institute for Oil Palm Research near Benin-City, Mokwa Station, Moor Plantation at Ibadan and the Agricultural Research Station at Umudike in 1960 were harvested. The design of the trials was a randomised block with four replications with three control varieties replicated five times in each block. The establishment of the trial at W.A.I.F.O.R. had been very good ; only 1.5 per cent of the total number of cuttings planted had died. Consequently, this is the only trial in which the yields were not corrected for different numbers of plants. The trial at Samaru had to be written off due to very poor germination caused by poor planting material. At W.A.I.F.O.R. variety 60444 gave a significantly higher yield than any other variety in trial with a production of 12.5 tons per acre. Variety 53101 was the highest yielding control with a production of 8.4 tons per acre. Other varieties which gave a higher yield than 53101 were 60471, 60488, 60520 and 60448. Their yields varied between 8.4 and 9.9 tons per acre. The diffrences in yield between these varieties and 53101 were not large enough to be significant. The three

highest yielding varieties are included in the variety trial at Effurun. The seven highest yielding varieties together with three other varieties and the local have been planted in a variety trial at W.A.I.F.O.R. The Western Region Ministry of Agriculture and Natural Resources has been provided with planting materials of 60444, 60471 and 60488 for inclusion in variety trials at Obior (Asaba Division) and Ilele (Afenmai Division).

At Mokwa seven varieties produced an actual yield of more than 10 tons per acre. Variety 60456 was the highest yielding variety with a production of 15.8 tons per acre. Contrary to previous results variety 43083 and not 53101 was the highest yielding control with a production of 7.6 tons per acre. After correction for different numbers of plants 60456, 60488 and 60448 gave a significantly higher yield than 43083 ($P=0.05$). The three highest yielding varieties are included in variety trials planted at Ilorin and Badeggi. The six highest yielding varieties together with six varieties of the 1960-61 variety trial and the local are planted in a variety trial at Mokwa.

At Moor Plantation and Umudike the yields were rather low. At Moor Plantation only four varieties produced over 5.0 tons per acre. Variety 60436 was the highest yielding variety with a production of 7.0 tons per acre. The highest yielding control, 53101, produced 4.7 tons per acre. After correction for different numbers of plants per plot 60436, 60435 and 60447 gave a higher yield than 53101. The difference in yield between 60436 and 53101 was large enough to be significant ($P=0.05$). Variety 60436 and 60435 are included in the variety trial at Agege and 60436 and 60447 are included in the trial at Ilora.

At Umudike variety 60520 gave the highest yield with a production of 6.6 tons per acre. Of the twenty selections tested, nine yielded above the mean yield of the controls. The thirteen highest yielding varieties were planted at Abak, Nekede, Abakaliki and Umudike, either in a variety trial or in collection plots. Enough planting material of variety 60520 was available to include it in the trials at Abak, Abakaliki and Umudike.

Uniformity Trial

Thirteen months and two weeks after planting a total of 2175 stands (80.7%) of variety 43083 were harvested and weighed individually. The yield results have been sent to Rothamsted Experimental Station for computation and the results have not yet been received.

Agronomy Trials

An experiment to study the effect of type of planting material on the yield of cassava showed that plants grown from cuttings taken from the base of primary branches of two low-branched and two high-branched varieties gave a higher yield than plants grown from cuttings taken from the base of the main stem. However, in 1956-57 it was demonstrated that plants grown from cuttings taken from the base of the main stem of three low-branched varieties gave significantly higher yield than plants grown from cuttings taken from lateral branches.

Plants grown from cuttings taken from the base of secondary branches of low-branched varieties, and plants grown from cuttings taken from the top of the main stem of high-branched varieties gave a lower yield than plants grown from other types of cuttings. The differences in yield between the different types of cuttings were not large enough to be significant. The experiment is to be repeated.

In the experiment which was laid down last year to investigate the effect of three different methods of planting on the yield of cassava, cuttings planted vertically gave a higher yield than cuttings planted horizontally. The differences in yield between different methods of planting were not large enough to be significant. The interaction between varieties and methods of planting was significant (P=0.01).

At Umudike severe damage of cassava cuttings is being experienced by the attack of termites. The use of various insecticides is being investigated.

Breeding Programme

The first stage collection and progeny trials of the 1957 series of pollinations which were planted at Moor Plantation and Ilora in late 1959 were harvested after eighteen months' growth. In all, 1854 clones had to be harvested. All clones were scored for cassava mosaic virus. The acquisitions based on the *M. glaziovii* × *M. utilissima* crosses continue to give the highest number of clones which show only slight symptoms of infection with cassava mosaic virus. The yields of the clones in the collection trials were expressed as a percentage of the mean yield of the replicated controls. Eight clones yielded more than double the mean yield of the controls. Seventeen clones in the progeny trials gave a theoretical yield of more than eleven tons per acre. One clone at Ilora, a selfing of 50100 produced a theoretical yield of 24 tons per acre. Sixty-three per cent of the hybrids selected for high yielding ability were the progeny of 53101.

Clones selected for their high yielding ability and tolerance to mosaic disease were planted at the selection centres ; W.A.I.F.O.R., Mokwa, Moor Plantation and Umudike. The highest yielding clones were planted in small scale progeny trials. Selections from the progeny trials will be included in future Regional Trials.

A total of 1274 seedlings of thirty-four different selfings and crossings from the 1959-60 series of pollinations were harvested at Moor Plantation and planted in their first stage of multiplication at Umudike.

Since no one variety has been consistently high yielding at all stations, and since the same interspecies hybrids have shown varying degrees of resistance to cassava mosaic virus at the stations, independent selections were made at W.A.I.F.O.R, Mokwa, Moor Plantation and Umudike for yield and resistance to cassava mosaic. The selections were incorporated in the 1961 breeding programme.

The objects of the 1961 breeding programme were to study the inheritance of variety characters ; to study the inheritance of mosaic resistance and to combine together the mosaic resistance of the interspecies hybrids with the high potential yield of *M. utilissima* interspecies hybrid.

Cassava Mosaic

The experiment on the effect of primary infection of cassava with mosaic virus on the yield of cassava at Samaru and Mokwa have been concluded. Randomised plots planted with cuttings from symptomless stocks and with cuttings from infected stocks (primary infection) of the varieties Zuru Local, Gama Gari, Samaru Dan Warri, Zonkwa Dan Warri and Doneji at Samaru and 43083 at Mokwa were harvested after twelve months growth. The mean yield per stand of plants grown from symptomless stocks was compared with that of plants grown from infected stocks.

Whereas the yield of infected Samaru Dan Warri plants in 1959 was 94.1 per cent of that of symptomless plants, and 94.3 per cent in 1960, the yield of symptomless plants was only 96.5 per cent of the infected plants. The yield of infected Doneji plants was reduced by 52 per cent, of Gama Gari by 69 per cent, of Zuru Local by 57 per cent, of Zonkwa Dan Warri by 1 per cent and of 43083 by 23 per cent. The differences in yield between symptomless plants and infected plants of Samaru Dan Warri and Zonkwa Dan Warri were not large enough to be significant. The differences in yield between symptomless plants and infected plants of the other varieties were highly significant. Symptomless plants of Doneji, Gama, Gari, Zuru local and 43083 produced a significant higher mean number of tubers per stand than infected plants.

Thus primary infection with mosaic virus reduces the formation of new tubers significantly and hence causes a significant reduction in the yield of the varieties Doneji, Gama Gari, Zuru local and 43083. The varieties Samaru Dan Warri and Zonkwa Dan Warri appear to be tolerant to the cassava mosaic virus.

YAMS

Collections

The National Museum of *Dioscorea* species, both wild and cultivated, is being maintained at Umudike. Approximately 580 varieties of the main economic species are at present in the collection ; these varieties are being multiplied for variety trials at centres throughout the yam growing areas and for experimental work at Umudike.

Observations on the morphology of the wild and cultivated species are being made at different stages in their growth. It has been found necessary to observe the plants at different physiological ages in order to produce a more comprehensive key to the varieties and species.

In recent years much interest has been centred on *Dioscorea* species which contain diosgenin which is a precursor for cortisone, an important drug. Seeds of two species, *D. floribunda* and *D. composita*, were received from the West African Stored Product Research Unit. These species are from Central America and their importance lies in the high diosgenin content which they contain. The seeds have been successfully germinated ; the seedlings are being grown under two different conditions, one group in the field and the second in baskets under shade. Under both conditions the seedlings are doing well.

A third diosgenin bearing species is D. (Testudinaria) *sylvatica*. The species has been in the collection for three years and the plants are showing good growth, but under Nigerian conditions they give a low multiplication rate. Therefore, it is doubtful, even if it does produce a high diosgenin content, whether this species would be economical for commercial cultivation.

Plant Breeding

The cultivated yam may or may not flower and it is suggested that in some varieties failure to produce flowers is a result of their phylogeny. However, varieties which flower do so irregularly and experiments so far attempted have not succeeded in determining the factor or factors controlling flowering. To investigate further the factor or factors controlling flowering an experiment was carried out in 1961 in which different weights and types of sett were planted.

The results were not encouraging, no flowers were observed in the variety used, but last year very few flowering varieties produced flowers. This failure to flower was probably due to late planting which was in April instead of March. The experiment is being repeated using different flowering varieties and it has been possible to plant earlier this year.

The seeds from the 1960-61 open-crosses have been germinated and transplanted to the field after a short time in the nursery. Individual clonal selections are now being made on open-cross progeny obtained in pollinations from previous years.

Collection and multiplication plots are being maintained at ten stations throughout the main yam growing areas in Nigeria. Where sufficient planting material is available variety trials are carried out. It is possible to obtain an indication of the potential of a variety by its performance during this period of multiplication. Inspection of the yield results received suggests that yields can be improved by the introduction of varieties from another area.

Sufficient material was available to lay down variety trials of the economic species *D. alata, D. cayenensis* and *D. rotundata* at Ilora Experimental Farm.

Six varieties of *D. alata* were tested for yield in a randomised block design. The gross yields ranged from 2.5 tons per acre (variety 667) to 6.7 tons per acre (variety 660). Six varieties of *D. cayenensis* were tested, the highest gross yield obtained was 3.4 tons per acre. This suggests that Ilora is too far north for this species as *D. cayenensis* requires at least a ten month growing season. The experiment is being repeated to confirm this observation.

A popular and high yielding local variety was included in the trial with nine varieties of *D. rotundata* from Moor Plantation. The local variety significantly outyielded ($P=.01$) other varieties. The local variety gave a theoretical yield per acre of 9 tons. It is planned to carry out twelve variety trials in 1962 at various stations in Nigeria. It should be noted that the slow rate of multiplication inherent in yams has caused a considerable delay in the progress of the variety testing programme.

Agronomy

The yam tuber in storage loses weight, much of this being due to the evaporation of moisture. For successful and complete germination of the tuber, or parts of it, moisture is a necessary condition. In storage a tuber may sprout, but growth of the stem will continue only as long as there is sufficient moisture in the tuber.

In 1961 a pilot experiment was carried out to study the effect on germination and yield of soaking the yam setts before planting. It is suggested that soaking the setts before planting might provide the tuber with adequate moisture for its immediate demands and thereby overcome the delay in germination due to intermittent rainfall. In the treatment of soaked setts it was observed that the rate or germination was greater than setts not soaked, although there was no significant difference between them in total number of setts germinated. The results obtained from the differences in yields indicate that further consideration should be given to this experiment.

At present, it is the standard practice on farms to ridge at three foot intervals irrespective of the crop being grown, the root room per plant being varied by planting distance along the ridge, rather than by changing the population density by varying both the width of ridges and the planting distance. Keeping this fact in mind, experiments have been attempted whereby the seed rate per acre is varied by firstly altering the sett weight and secondly the planting distance. Instead of varying the seed rate per acre, as is usually done, it was considered more practical to vary the sett weights at 4 ounce intervals from 8 to 20 ounces. The planting distances, were 6, 4, 3 and 2 foot spacings on 3 foot ridges. The experiment was carried out using tubers from *D. rotundata* and *D. alata.*

In the experiment using *D. rotundata* the highest gross yield was obtained from 16-ounce setts planted at 2 feet spacing (figure 1). Two feet spacing was significantly better than any other spacing under consideration. Overall, twenty ounce setts were superior to lower sett weights. There was no interaction effect between spacing and sett weights.

The larger sett weights and closer spacing give a high gross yield but their seed rates are also high (fig. 2) and are therefore uneconomical. The best sett weight was 8 ounces at 4 foot spacing which gave the highest ratio of gross yield to seed rate (fig. 3) and also nett yield to seed rate.

In the second experiment, using *D. alata,* 20 ounce setts at 2 foot spacing was better than other treatments (fig. 4). The higher sett weights gave bigger yields than the lower, and closer spacing was better than wider spacings (fig. 5). Again there was no interaction effect. The most economical sett weight was 8 ounces planted at 6 foot spacing (fig. 6) followed by 8 ounces at 4 foot spacing.

The results from these experiments can serve as a useful guide to future experiments. It is necessary to continue similar experiments at different stations and use more than one variety. Future experimental work should also consider the effect of varying the width apart of the ridges as well as the planting distance along the ridge.

Storage Trial

Yam tubers during storage incur a high storage loss as a result of respiration, evaporation and storage rots. A loss of from 30 to 40 per cent may be found during a storage period lasting from 4 to 6 months. These rots occur mainly as a result of bad handling during harvest ; the tubers may be bruised or damaged by cutlasses and the wounded areas are subsequently colonised by fungi. In some cases damage to the tuber may be caused by insects. An experiment carried out two years ago showed that storing the tubers in a pit instead of the barn reduced the loss and in particular the loss due to rots.

In 1960 a further pilot experiment was carried out at Ilora. In this experiment the tubers were dusted with or dipped in insecticides and fungicides and the tubers stored in either a barn or a pit. Each tuber was weighed before and after storage treatment. The insecticides used were Gammalin A, and Aldrin 2.5 per cent and fungicides Perenox, Sulphur, Hydrated Lime and White Lime, the last two at 1 per cent concentration.

The additional effects of the storage treatments were to be tested by a germination experiment and palatability test, but only the first of these could be attempted.

The results summarised in Table I show that there was a greater loss due to rotting in the pit than in the barn but the total loss in weight was less in pit storage. This confirms the result found in the earlier experiment.

The germination was higher from setts cut from tubers stored in the pit than in the barn, although germination from all treatments was very poor. This does not agree with the result from the 1958 experiment in which it was found that the tubers from barn storage gave higher germination.

It is hoped to repeat this experiment with modifications.

TABLE I.—INSECTICIDAL—FUNGICIDAL TREATMENT OF YAM TUBERS IN STORAGE, STORAGE PERIOD 110 DAYS

Treatment	*Percentage loss due to rot*		*Percentage total loss in Weight*		*Percentage germination*	
	Barn	*Pit*	*Barn*	*Pit*	*Barn*	*Pit*
Control	4.4	13.0	29.1	18.6	13.3	24.0
Gammalin	20.4	45.0	35.1	23.2	15.5	10.6
Aldrin	21.2	35.5	28.6	23.0	23.5	12.8
Perenox	4.8	15.0	30.1	24.4	10.2	16.1
Perenox/Gammalin ..	27.5	45.8	31.4	24.9	11.8	24.5
Perenox/Aldrin	13.4	26.6	28.4	18.7	14.3	26.9
Sulphur	25.0	27.4	31.5	25.0	5.9	14.3
Sulphur/Gammalin ..	10.8	60.5	29.4	22.7	3.7	12.9
Sulphur/Aldrin	5.8	10.0	27.1	22.0	1.6	17.0
Lime hydr.	14.7	13.3	24.3	16.0	0.0	23.7
Lime hydr./Gammalin ..	9.9	23.2	31.6	27.0	3.0	26.8
Lime hydr./Aldrin ..	13.9	26.2	29.5	17.0	6.5	13.6
White Lime	12.6	14.2	25.0	18.4	5.8	15.6
White lime/Gammalin ..	21.8	61.9	29.9	27.6	3.3	7.7
White Lime/Aldrin ..	10.8	25.0	31.4	22.8	4.1	3.4
Mean	14.5	29.5	29.5	22.1	8.2	16.7

SWEET POTATOES

The sweetpotato in the South of Nigeria is not a popular food ; in the north it is more favoured but is not widely grown because of low yields and severe attack by the sweetpotato weevil (*Cyclas puncticolis*). During the past five years research at Moor Plantation has improved the yield threefold and improved agronomy can give some measure of control against weevil attack.

It is regrettable that a crop which has a high food value and can be suitably adapted into most crop rotations has not been more fully exploited. It is hoped that greater attention will be paid to the potentialities of sweetpotatoes in the domestic, industrial and livestock fields.

Plant Breeding

One variety and two progeny trials were carried out in 1961. In the first trial ten parent varieties were tested for yield in a randomised block design with four replications. The highest yielding varieties were 2292 (6.2 tons/acre) and 2291 both of which came from the United States of America.

After initial selection for establishment and field resistance to virus diseases the progeny from the 1957-58 and 1958-59 series of pollinations were tested for yield. In the first trial sixteen progenies were tested against two parents and a high yielding open cross selection. The design of the experiment was a balanced incomplete block. The standard variety gave a yield of 10.2 tons per acre and three progenies gave yields greater than 7.6 tons per acre. In the second trial twelve progenies were tested against three parent varieties in a balanced design. A high coefficient of variation was found due to the low yields, and in some cases no yield at all, of some progenies. The standard variety 0116, again gave a good yield (9.4 tons/acre) with three progenies producing a theoretical yield per acre of more than 7 tons.

It was not possible to carry out further cross-pollination series due to the transfer of staff. However, as some success has been found with open-crosses this series was continued and the seeds collected and germinated.

Selected material has been transferred to Umudike where it will be under observation for one year before the programme is rephased. It is hoped to increase the present collection with introduction from the United States.

Agronomy

In 1960 an experiment to study the effect of time of harvesting and spacing was laid down. The results from that experiment showed that harvesting 160 days after planting gave lower yields than harvesting after 180 days, but the tubers were in a much better condition, they had fewer cracks and suffered less from attack by weevils. This experiment was repeated in 1961 ; the cuttings were planted at 8, 12 and 18 inch intervals and harvested at 140, 160 and 180 days after planting. The experiment supported the 1960 results, including the fact that closer spacing favoured higher yields.

It is possible to obtain some measure of weevil control by spraying at 14 to 21 days intervals with Aldrin, but it has not yet been determined whether or not such frequent spraying are economical.

SOIL FERTILITY

Mr M. H. D. F. Fyfe arrived in November. In early December Dr H. Greene, Adviser on Tropical Soils, and Mr A. J. Vernon, Statistician at Rothamsted, visited Ibadan to discuss the planning and implementation of research into the improvement and maintenance of soil fertility in the forest zones of Nigeria. At a three-day conference the proposals for experimental work at Moor Plantation were thoroughly discussed, research staff from the Western Region being keenly interested as they are running a series of closely related trials at different sites throughout the West of Nigeria. The Western Region was strongly represented and officers of W.A.C.R.I. and W.A.I.F.O.R. made valuable contributions to the discussions.

It was agreed that "the broad objective was the search for an alternative to bush fallow for the restoration of fertility to forest and fringe soils following several years of cropping." A 20 acre field on Moor Plantation which had been heavily cropped for many years but rested under grass for the past four years was considered to be a suitable site for a trial. It was agreed that the following three systems should be compared : (1) The use of grass fallows ; (2) The use of grass leys, which would be cut as forage and fed to livestock, dung being returned in proportion to the forage harvested per plot ; (3) Continuous cropping.

It was also agreed that within systems (1) and (2) a comparison between four mixtures be used and that these should consist of (*i*) *Andropogon gayanus* (*ii*) *Andropogon gayanus* plus *Stylosanthes gracilis,* (*iii*) *Tripsacum laxum,* (*iv*) *Pennisetum purpureum.* A 23 factorial with N., P and K to be superimposed on these treatments and a simple rotation consisting of cassava, late maize and early maize, would be used to test the fluctuations in fertility. It was also agreed that proportions of fallow to crop should be investigated by comparing proportions of four years fallow to four years cropping and four years fallow to eight years cropping.

During the next three months the field selected for the trial was surveyed, the contours were checked and scale maps were prepared. Plots were marked out according to the trial agreed upon by the conference.

On 3rd February, a day of exceptionally low humidity, a fire started in the north-east corner of the plantation near the railway and spread, despite the efforts of staff and the local fire brigade, to the field selected for the trial. The tinder-dry grasses burnt fiercely and rapidly, revealing a thick carpet of worm-casts. Fortunately the burn was so rapid that little damage was done to the growing portions of the grasses and within six weeks new growth had provided a good cover.

PLANT PATHOLOGY

Plant Disease Survey

The main emphasis in this field of work was given to the preparation of the Revised List of Plant Diseases in Nigeria, which will provide all those concerned with plant diseases in the Federation with up to date information. The last publication of this type was the List of Plant Diseases written by J. West in 1938 and a revision of this is urgently required. The Revised List will have a full bibliography of Plant Pathology in Nigeria, and it is hoped that it will be published by the beginning of 1963.

The Mycologist toured Eastern Nigeria in August, and collected specimens of plant diseases. Specimens have been received from the Department of Agriculture, Southern Cameroons, the West African Cocoa Research Institute, and the Federal Department of Forest Research, Ibadan.

VIROLOGY

Cowpea Yellow Mosaic Virus

Host Range.—The virus has not been found naturally infecting any leguminous hosts except cowpea. The following species have been found to be susceptible to systemic inction by the virus under greenhouse conditions: *Centrosema pubescens, Calopogonium mucunoides, Crotalaria intermedia, C. juncea, C. lanceolata, C. mucronata, C. retusa, C. spectabilis, Phaseolus acutifolius, P. aureus, P. calcaratus, P. lathyroides, P. mungo, Psophocarpus tetragonolobus, Pueraria javanica, Pisum sativum, Soja max, Sphenostylis stenocarpa, Vicia faba, Celosia argentea, Amaranthus caudatus, A. viridis.*

Local lesions developed on the inoculated leaves of *Cajanus cajan, Canavalia ensiformis* and *Voandzeia subterranea,* and in the latter species systemic infection subsequently developed. Chlorotic lesions and systemic infection developed on *Chenopodium amaranticolor* and *C. quintos.*

Arachis hypogea, Dolichos lablab, Stylosanthes gracilis were not susceptible to infection.

Strains of the Virus.—Isolates from Igporin district in Ilorin Province while producing normal symptoms in six leguminous species and eighteen French bean varieties did not infect *Amaranthus caudatus* or *A. viridis.* Inoculated plants of *Crotalaria juncea* either remained symptomless or only produced a very mild mottle about 4 weeks after infection. The type isolate causes severe mottling in the newly expanding leaves of *C. juncea* 5-10 days after inoculation.

Field Trials.—A study of the effect of the disease on the yield of cowpeas gave similar results to those previously reported. Infection of the variety New Era at two weeks after planting reduced the yield of dried beans by 60 per cent. Later infections did not reduce the yield and this appears to be correlated with the time of flowering of the plants.

Cowpea Mottle Virus

The new disease of cowpea previously recorded from Ilorin Province has been found in Ibadan, Oyo and Niger Provinces. Its distribution appears to be quite extensive and in some areas it is undoubtedly of importance. The vector is not yet known.

Preliminary studies on the virus indicate that it is different from previously described viruses that infect cowpea. The name Cowpea Mottle Virus is proposed.

The virus has been transmitted by sap-inoculation to *Phaseolus acutifolius, P. lunatus, P. lathyroides,* and *Voeandzeia subterranea.*

Suspected Yam Virus

The disease survey was continued throughout the season and the results indicate that the disease is not of economic importance.

Affected white yam plants were found on native farms only on a few occasions. On the government experimental stations at Ilora (Western Region) and Mokwa (Northern Region) the disease incidence was high in yellow and white yams respectively. A similar condition was recorded on white yams at Agege (Western Region). These were the only area where the disease was important in 1961.

The disease was not transmitted by mechanical methods or tuber core-grafting. Healthy white yam plants did not become infected when grown in soil that previously had supported a crop of diseased plants.

The information to date supports a theory that the disease is caused by an upset in the physiological balance of the plant. The main evidence in favour of this theory is that severe symptoms and high disease incidence have only been continually recorded in material that is used repeatedly in N.P.K. fertilizer trials.

Sweet Potato Virus Complex

Observations have been carried out during the past two years on a mosaic disease complex of sweet potatoes at Moor Plantation.

There is a great variation in the symptoms recorded in the numerous sweet potato varieties studied but there is no evidence as to the number of viruses present. The most obvious symptoms are stunting of the plant, vein clearing of the leaves accompanied by chlorotic areas along the main veins and general leaf mottling. These symptoms may appear singly or in combination. In varieties with much dissected leaves, the segments may be strap-shaped, while some entire leaf varieties may have the lamina reduced in size and with a marked cuspidate apex.

The virus complex has been transmitted by top wedge grafting and tuber core-grafting but mechanical methods have been unsuccessful. Preliminary experiments using *Aphis gossypii* and *Bemisia tabaci* as vectors have given negative results.

Mycology

A large number of collections were made during the year and a detailed report will be made on new and unusual records after they have been examined at the Commonwealth Mycological Institute. The following preliminary report on crop-disease fungi is given.

Cacao

Two 10 inch high seedlings were received from W.A.C.R.I. in June which had been raised at Abeokuta, showing unusual die-back and proliferation of the stem apex. No micro-organism was associated with the condition, and it is thought that it was caused by insect damage. No further report of its occurrence has been received.

Capsicum

Plants showing wilt symptoms occurred at Moor Plantation in November, the suspected bacterial wilt due to *Pseudomonas solani* was not confirmed.

Cowpea

Bacterial blight (*Xanthomonas phaseoli*) was recorded on plants at Ilorin in June, causing leaf spotting on variety 'Blackeye'.

Corynespora leafspot and mildew (Oidium sp.) occurred on plants in the greenhouse at Moor Plantation. Partial control of the mildew was achieved by dusting with sulphur.

Stem anthracnose caused by a Colletotrichum species close to *C. capsici* (Syd.) Butl and Bisby, affected plants in May at Moor Plantation. As has been noticed before, this disease appears to be associated with damage to the stems at soil level, probably during weeding.

Sclerotium rolfsii Sacc. was the cause of the common stem rotting in the field in July at Moor Plantation.

Citrus

Utilina deusta (Hoffm. ex. Fr.) Petr. was observed on a moribund grapefruit tree which fell during a heavy storm in May at Moor Plantation, and specimens of it were sent in from Kumba, Southern Cameroons for identification.

Ginger

A species of *Piricularia* was found to be associated with leaf-blotches on plants in the Economic collection. Further collections will be necessary to confirm whether or not this is *P. zingiberi Nisikado.*

Maize

In a date-of-planting (monthly), observation trial, grey-spot, caused by *Piricularia grisea* in May at three to seven weeks old. Several factors are concerned in the occurrence of grey-spot, including presence of inoculum, age of plants, and weather conditions. The disease is not serious, as unlike the majority of foliage pathogens it is apparently restricted to young plants and a serious reduction in effective leaf area at flowering and fruiting times is not produced.

Radish

Some experimental plantings made by the Horticulturist were heavily infected with *Alternaria* sp. causing severe leaf-spotting, in October at Moor Plantation.

Lima bean

Living material of *Cercospora canescens* Ell. and Mart. on lima bean leaves was sent to Dr Bond of Bristol University in March.

Fluted Pumpkin (*Telfairea occidentalis*)

Cercospora citrullina Cke. was recorded from Moor Plantation, and *Colletotrichum lagenarium* (Pass.) Halst and Ell. from Umudike Farm, Umuahia.

Gmelina arborea

Specimens of a root rotting fungus sent in by the Federal Department of Forest Research from Ogoja in June were identified as *Polyporus baudoni* Pat. by the Commonwealth Mycological Institute.

Sweet Potatoes

The so-far undescribed Corticum sp. responsible for the zonate brown leaf-spot which appears on sweet potatoes very commonly in the Southern part of Nigeria, in the middle of the rains, was isolated in pure culture. No evidence was obtained to indicate that any dispersal of the disease took place by means other than the very sparsely produced basidiospores. The disease is not serious, certain varieties are apparently more susceptible to it, and wild Ipomoea spp. are commonly infected.

Yams

Dioscorea esculenta was attacked by Rhizoctonia sp. (probably *Corticium solani* (Prill and Del.) Bourd and Galz.) at Moor Plantation : *Sclerotium rolfsii* Sacc. caused conspicuous leaf lesions on *D. dumetorum* at Umuahia : neither were serious.

The striking wilt and die-back of water yam, *D. alata* which has been observed in previous years, occurred seriously at the Regional Research Station, Umudike, in the variety collection of the Federal Yam Research Unit. This followed a severe attack of leaf-spotting associated with *Gloeosporium* sp. earlier in the season. Specimens of entire plants were examined but the cause of the disease has not been definitely established. It is suspected to be a severe form of anthracnose caused by Glomerella cingulata (Stonem) Spauld and von. Schrenk.

ENTOMOLOGY

Bemisia (Mr F. A. Squire)

Reproductive Index and Sex-ratio

In order to supplement quantitative data previously obtained, work on the reproductive index and sex ratio of the parthenogenetic generation of *Bemisia* was continued using four economic host plants *viz* : cassava, cotton, tobacco and *Capsicum.* It was found that the reproductive index of parthenogenetic females is significantly lower on *Capsicum* than on the other three host plants ; no other significant differences appeared.

The Incidence of Prospaltella

Studies in the incidence of the encyrtid hymenopterous parasite Prospaltella sp. of Bemisia were continued on cassava, tobacco and cotton in the insectary. In the field the incidence was generally on the low side, never rising above 12.3 per cent ; but in the insectaries once the parasite became established its incidence was generally much higher, reaching 40.3 per cent on cassava during December. It was generally lower on tobacco than on cotton and cassava. A curious phenomenon that has never been adequately explained is the total absence of *Prospaltella* on *Bemisia* on tobacco in the field. On cassava in the field there is a slight but significant seasonal variation from month to month.

Cola-Borer (Phosphorus virescens Olivier)

Observations on field populations in the main cola producing area were continued. For the first three months of the period under review, that is, April to June, almost the entire population was in the larval stage with the exception of some pupae discovered towards the end of May. There is a fairly high rate of natural larval mortality rising to nearly 24 per cent on occasions in some localities. Its cause was not precisely ascertained but is probably a combination of several factors including the action of predators. Of the larvae collected in the field for study and observation some 260 were placed in cola cuttings in the insectary. Of these 95 (40.3 per cent) pupated and 36 of the pupae (37.9 per cent) eventually emerged as adult beetles. The pupal period ranged from 22 to 36 days. The mean was 30.69 + 0.66 days.

A further 155 larvae also collected from cola in the field were reintroduced by means of artificial burrows into living cola trees on Moor Plantation. Of these 6 (3.9 per cent) pupated, and 82 died leaving 67 still in the larval stage.

Of 62 larvae introduced into living coffee trees by the same technique many continued to feed for several weeks but all eventually died without pupating. After this no further attempt was made to rear *Phosphorus* larvae on this host plant. Of 121 larvae similarly introduced into living cocoa trees 56 (46.3 per cent) pupated.

This year for the first time a predator in the shape of a large staphylinid larva attaining a maximum length of 2½ inches was observed in the burrows feeding on *Phosphorus* larvae. It is extremely voracious and goes from burrow to burrow seeking out and destroying its host. Unfortunately it is by no means common and the few well grown specimens taken defied all efforts to rear them through to adults so that we are left in ignorance regarding the specific identity of this important predator.

Owing to pressure of other duties it was not possible to continue observations on the hymenopterous abdominal parasite of adult beetles during the months when they were about *viz* : September and October.

Chemical Control

Experimental spraying with the organo-phosphorus systemic insecticide Rogor 40 was continued during January and February. It is at this time of the year that *Phosphorus* is thought to be most vulnerable as the larvae are then still feeding in the green translocatory tissue where they are more likely to come into contact with the insecticide than they are later in the year when they mainly inhabit older woody tissue : moreover the insecticide also has a better chance of being taken up by the plant during these dry months. Residue analysis done by Fisons, revealed an appreciable uptake of insecticide into the tissues surrounding the burrows of the larvae. There was no detectable dimethoate residue in the samples of cola nuts submitted. As in the previous year the results obtained indicated that a fair degree of control could be achieved by foliar application at this time of the year. But it was evident that this insecticide has an uncertain shelf life and in some of the experiments it appeared to be quite inactive. This uncertainty is very unsatisfactory in experiments and makes it impossible to recommend the insecticide for large scale control at present.

Dorylus Investigation

Twenty-one *Dorylus* nests were opened and 14 queens found, never more than one per nest, at depths varying from three inches to 2½ feet below the surface of the soil. Seven nests were apparently queenless. A number of male pupae were obtained from one nest in March and adult males were observed in another during February. All the nests contained immature stages of the worker and soldier casts so evidently queens had been present in all the nests and must have been killed off at some time prior to excavation. An armoured larval mite containing mature eggs regularly appears as an ectoparasite on the queens. Otherwise the nests seem to be remarkably free from extraneous arthropods.

Odontopus Sexpunctatus

Observations were continued and once again quiescent colonies were found sheltering on the underside of branches of *Hildegardia barteri* trees throughout the entire rainy season from April to November neither moving nor feeding. With the onset of the dry season they again became active and started breeding under the leaf litter surrounding the trees. By the end of March which completes the year under review they were still active. This confirms previous observations.

Aphid and Psyllids Population Studies

Determinations have been received of aphids and psyllids for the year under review up to September. Both were prevalent throughout the period but psyllids reached their peak in April and May due mainly to the high incidence of *Mesohotoma tessmanii* and *Phytolima lata*. *Rhinopsylla lamborni* however was most

numerous in June. June to September were the best months for aphids the emphasis being on *Pentalonia nigronervosa* and Toxoptera *citricidus*. These observations have been discontinued at Moor Plantation as sufficient data have now been accumulated.

Locusts

There were no reports of locust invasions of Nigeria but the tree locust *Anacridium moestum* was active during November and gave rise to several false reports of desert locust.

Light Trap Records

A mercury vapour light trap was operated three times a week at regular intervals at Moor Plantation. All the main orders of insects were well represented, the best catches being made during the rains from March to November. Dark nights gave better results than moonlight nights.

In the Orthoptera several species of *Gryllus* and *Gryllotalpa* of economic importance appeared regularly.

The Rhynchotal was well represented at all times by Pentatomids of ten different species, Pyrrhocorids of three species and a good range of some eight species of Reduviids or assassin bugs.

The Coleoptera apart from the super-family Scaraboidea was somewhat disappointing. Special attention was paid to the Carabidea, the Cerambycidae and the Staphylinidae. In the Carabidae four species were taken fairly regularly.

Oddly enough the Cerambycidae which usually frequent at lights have been conspicuous by their absence with the exception of a few specimens of *Xystocera.*

The Staphylinidae were represented by several species including the notorious West African blister beetle, *Paverus* spp. Among the Diptera, tachinids such as *Sturmia inconspicua* a pupal parasite of the West African silk moth *Anaphe* were taken at the beginning of the rains; while the tabanid *Tabanus subangustus* was trapped throughout the year in fair numbers.

By far the greatest contribution to the catches came from the Lepidoptera notably the Sphingidae, Noctuidae, Notodontidae and Arctiidae. These were so numerous that it was not possible to cope with them even on a selective basis with the staff available beyond recording the most frequent species.

Miscellaneous Pests

There was a wide spread attack of Army-worms, *Laphygma* sp. on maize in May and cowpeas were again heavily infested with the galerucid beetle *Ootheca mutabilis.* The variegated grasshopper, *Zonocerus variegatus* occurred in considerable numbers during the early rains in a wide range of crops including cassava and cowpeas.

Yam-Beetles (Dr T. Ajibola Taylor)

The investigation on the bionomics of yam-beetles was resumed on Dr Taylor's arrival from U.K. in January 1961. An extensive tour of the yam-beetle affected areas of Western and Eastern Nigeria was undertaken to collect and collate information on the yam-beetle problem. Detailed proposals for the continuation of the investigation have been submitted and are under consideration.

Light-trap

Only 2 yam-beetles, belonging to two different genera, were caught in the light-trap operated on Moor Plantation during the first three months of 1962: *Heteroligus appius* was attracted to light on 20th February, much earlier than the normal time recorded for beetle flight in other parts of the country; *Prionoryctes rufopiceus* was trapped on 4th March. This is the first time that *Prionoryctes* has been recorded outside the Southern part of the Lowland Rain Forest Vegetation Zone near to the creeks, to which area it was believed to be restricted. It may well be that *Prionoryctes* has as wide or nearly as wide a range of distribution as either *H. meles* or *H. appius*.

Biology

Laboratory studies on the biology of yam-beetles have been handicapped by shortage of material. It is hoped that this will improve with the onset of the migration period.

The only female *H. appius* which was caught in the light-trap and caged in moist soil in the laboratory started ovipositing 8 days later. The beetle lived for 42 days and laid 19 fertile eggs over a period of 10 days and a last, probably infertile, egg two days before it died. Of the 19 fertile eggs only 4 were successfully incubated to produce first stage larvae. Average incubation period under laboratory conditions was 17 days.

The majority of eggs decomposed during incubation and it was suspected that this was due to excess water after a particular stage in the embryonic development. Different techniques for the incubation of eggs and rearing of larvae are being evolved in the laboratory. Open-ended 3 in.×3 in. tubes filled with moist soil and standing in a patri-dish containing water (approximately soil at "field capacity") have been tried for the incubation of eggs. It has been observed that embryonic development proceeded normally in this medium for 10 days, but that eggs decomposed if left in this medium for the remaining period of incubation. Successful incubation was achieved by transferring eggs into ordinary moist soil (approximately at "wilting point") after the tenth day, for the remaining period of incubation. It therefore appears that free water is only necessary for the initial phase of embryonic development and may be detrimental in the latter part of the incubation period.

Breeding Areas

From the information collected about yam-beetle incidence and flight, in the records and from different parts of the country, a tentative map of yam-beetle breeding areas has been prepared. The only well-known breeding area stretching from the confluence of the Niger with the Benue to the Creeks is to be referred to as the "major" breeding area and other suspected "minor" breeding areas along such all-season rivers as the Ogun, the Ogbesse and Osse in the Western Region, and the Imo and Cross Rivers in the East are to be investigated. This map is expected to be modified as more of the suspected "minor" breeding areas are investigated.

Miscellaneous (Mr S. O. Boboye)

Mr S. O. Boboye assumed duty as Specialist Officer Entomologist on 26th September, 1961. His first assignment was to help with the reorganisation of the insect collection. He also began an investigation of the insect pests of cowpeas at Moor Plantation. Severe damage to pods was caused by a number of pyralids

and lycaenids. Several mites found infesting cowpea root nodules were identified by the British Museum (Natural History) as species of Oplites, Scheloribates, Protoribates and Cyrthermannia. They occurred in considerable numbers causing putrefaction of the nodules. On the departure of the Principal Research Officer (Entomologist) on leave on 11th November, 1961, Mr Boboye took charge of the Entomological Division until his own departure to attend a course in Desert Locust control from 19th February to 15th April held in Asmara, Ethiopia under the aegis of the Food and Agricultural Organisation.

Cereal Pests (Mr K. M. Harris)

Stem Borers

Northern Region.—The results of research on cereal stem borers, which has been carried out in Northern Nigeria since 1955, were written up for publication. As a result, little new work was undertaken.

Observation plots of guineacorn and millet, grown at Samaru, yielded no new information but results of considerable interest were obtained from an insecticide trial on maize, which was also sited at Samaru.

In this experiment five insecticide treatments were compared with untreated control plots. The treatments with endrin spray, endrin 2 per cent dust, sevin spray, sevin 5 per cent dust and DDT spray were applied once only, on 10th August, in an attempt to control attack by the second generation of Busseola fusca and they were all applied at the rate of 1 lb. active ingredient per acre.

The assessments of stem borer attack and yield are summarised in Table 1.

TABLE I: SUMMARY OF MAIZE STEM BORER INSECTICIDE TRIAL
SAMARU, NORTHERN NIGERIA, 1961

Randomised Block layout: 6 treatments x 5 replications.

Plot size 150 stands at 2 ft. on 3 ft. ridges
=1/48.4 acre.

A/. STEM BORER ASSESSMENT AT HARVEST (Plot means)

Number of	*Endrin spray (A)*	*Endrin dust (B)*	*Sevin spray (C)*	*Sevin dust (D)*	*DDT spray (E)*	*Control (F)*	*Significant Differences*
Stems bored ..	34.4	35.4	39.6	50.8	48.6	44.2	A<D**, E*; B<D, E*.
Stems bored, borer present	6.02	6.40	17.00	15.60	20.80	19.80	A, B<C, D*, E, F**.
Busseola fusca collected	3.4	3.6	22.0	21.2	25.8	24.6	A<C, D, F**, E***; B<C, D, E, F**.
Sesamia spp. collected	4.0	4.6	2.4	1.8	3.0	1.6	n.s.
Eldana saccharina collected	1.2	1.4	3.4	1.0	2.0	4.6	n.s.

B/. Yield (Plot means)

	Endrin spray (A)	*Endrin dust (B)*	*Sevin spray (C)*	*Sevin dust (D)*	*DDT spray (E)*	*Control (F)*	*Significant Differences*
Number of Stems	143	139	139	140	140	139	n.s.
Number of Cobs	137	138	141	140	139	141	n.s.
Number of Cobs with no grain	11.4	10.8	4.6	6.2	6.6	6.8	A. B>C**, D, E, F*.
formed Mean weight of Cob (lb.)	0.230	0.248	0.246	0.253	0.255	0.258	n.s.
Weight of grain (lb.)	25.2	27.4	28.0	28.6	28.8	29.4	n.s.

The count of 'stems bored' was mainly based on circumstantial evidence of the previous presence of borers and was therefore not as accurate as the count of 'stems bored, borer present' which depend on the presence of living or dead larvae and pupae or empty pupal cases at harvest. This count, together with the count of living *B. fusca* larvae and pupae, clearly demonstrates the superiority of endrin spray and dust in controlling this species. (The failure of endrin to control *Sesamia* spp.—mainly *S. calamistis*—and *Eldana saccharina* is to be expected since the habits of the newly-hatched larvae of these species are less likely to expose them to the full effects of contact insecticides.)

However, despite the good control of *B. fusca* achieved by the endrin treatments, they failed to produce any increase in yield above that of the control plots. A similar effect of endrin spray has been noted in stem borer control experiments on maize at Ibadan. Here it was thought that the failure of endrin to increase yield was due to excessive competition for nutrients by the more dense plant populations which resulted from borer control. But this argument cannot be applied to the experiment at Samaru, which suffered so little loss of stand that the plant populations in all treatments were virtually identical, and the fact that both endrin treatments produced significantly more empty cobs than any of the other treatments strongly suggests that, in this case, the insecticide had a phytotoxic effect on the crop. This aspect of maize stem borer control needs to be studied in greater detail in future.

Ibadan.—The insecticide trial on second crop maize at Ibadan was repeated for the fourth successive year. The site allocated for this experiment was not good and the weather at planting time was unfavourable. As a result, germination losses averaged more than half of the overall losses of stand throughout the experiment. In untreated control plots stem borers caused the loss of only 4.75 per cent of all stands planted whereas germination losses amounted to 11.12 per cent of stand planted.

All plots treated with insecticide lost significantly fewer stands to borer than did the control plots and plots which had been treated with endrin spray lost significantly fewer than those treated with DDT and BHC.

The overall yield of 407 lb. of threshed grain per acre was unusually low, probably due to the poor land and poor season, and no increases of yield resulting from stem borer control were detected. There was also no evidence of the possible phytotoxic effect noted in the similar experiment at Samaru.

Sugarcane borers.—During the year, an outbreak of stem borers at the newly established sugar estate at Bacita was investigated. *Sesamia nonagrioides botanephaga* Tams and Bowden was present in considerable numbers in late July and early August, and, since such borer outbreaks may seriously affect the embryo sugar industry, detailed investigations of stem borers at Bacita were proposed and will commence early next year.

Sorghum Midge

Preliminary observations on the biology, ecology and control of the sorghum midge (*Contarinia sorghicola* Coq.) were published early in the year. Towards the end of the year booklets and posters in English and Hausa were prepared for the use of extension workers in the Northern Region. It is hoped that wide use of this extension literature will help farmers to recognise the pest and control it by cultural measures.

Examination of part of the Kew Herbarium material of the genus Sorghum has lead to the discovery of *C. sorghicola* in specimens of guineacorn collected in Nigeria in 1929, 24 years earlier than the previous first record of its presence in the country. Fuller details of this work have been published elsewhere.

An interesting side-line of the Sorghum Midge Survey of 1957 and 1958, which was developed during the year, was the assessment of the levels of the infection of guineacorn by covered smut (*Sphacelotheca sorghi*) during the two years of the survey. In both years the overall level of infection in Northern Nigeria was about 1 per cent of all spikelets examined, a loss which is equivalent to the loss of £500,000 worth of grain or the unrewarded cultivation of at least 70,000 acres per annum. The severest smut infections were mostly recorded from those provinces in which the mean air temperature at planting time is comparatively low. Despite inadequate meteorological data available for some of the provinces, the linear regression of the level of smut infection on the mean air temperature for May and June was significant in 1957. Full results will be published elsewhere.

PLANT QUARANTINE SERVICE

6th Annual Meeting of Inter-African Phytosanitary Commission

From 16th to 20th October, the Annual Meeting of the Inter-African Phytosanitary Commission was held at the Headquarters of the Federal Department of Agricultural Research, Moor Plantation. This was the first time that the Commission had met outside London, and it was generally felt that it was most stimulating to discuss the problems connected with plant quarantine and plant protection in Africa, at an African Agricultural Research Station, as a result of the invitation given to the I.A.P.S.C. by the Nigerian Government.

Stations

Ibadan.—This year saw the long-awaited construction of the Plant Quarantine Building at Moor Plantation. Work was started in May and the contractor handed the building over to the Ministry of Works in September. Despite several minor modifications in the equipment of the building which were decided on after it had been used for six months, its layout has proved to be very suitable for the handling of plant material. It is the first building in Africa to be expressly designed for the inspection and treatment of imported plants and

seeds to eliminate the risks of introducing pests and diseases. Plant material is inspected in an insect proof cubicle and may be examined microscopically and be given any of a range of chemical or heat treatments (or if necessary destroyed) without risk of spread of any disease or pest. The inspection and treatment section is combined with a soil preparation unit, where plants or seeds which are going to be grown under observation in the greenhouse, are potted up.

The Central Office of the Plant Quarantine Service is also included in the building. The growing of imported plants in insect-proof houses is an important aspect of the plant quarantine work and during the year seven houses were added to three already in use, giving a total of twenty separate compartments for this purpose. Nine compartments have glass roofs, and are used for delicate subjects such as seedlings, the remainder are screenhouses. The station was inspected by a Committee of the Inter-African Phytosanitary Commission during the 6th Annual Meeting at Ibadan and was given provisional approval as an international plant quarantine station.

Apapa.—In September, the Federal Department of Agricultural Research took over an office near the Board of Customs and Excise, Apapa, Lagos. A Plant Quarantine Officer was posted there to initiate port inspection at Ikeja, Apapa and Lagos. In the short time in which this work has been carried out it has been abundantly clear that no effective phytosanitary control of imports can be done without a much larger inspectorate at Lagos.

Kano.—The Plant Quarantine Officer, Kano, started routine inspection at the airport and the Post Office at the beginning of September, although the Plant Quarantine Station was not taken over until November.

Calabar.—After fencing of the Station grounds had been completed, in February, a start was made in raising rubber rootstocks for the proposed clonal collection. Preparations were also made for propagating material of the newly imported avocado varieties which are at Ibadan.

Plant Importation

One hundred and thirty-seven Import Permits were issued during the period. The volume of requests for permits increased considerably in the second half of the year as a result of the inspection work being carried out at Lagos and Kano, by which means a large number of the public have been made aware of the control of Plant Importation. The different types of plant material which were inspected on importation in Nigeria are noted below.

Vegetable and Flower Seeds

This is the largest category of imports, with little phytosanitary risk except in the cases of maize, tomatoes and peppers. Nigeria's expanding market garden industry is still largely dependent on seed from Europe and this seems to account for about one half of the vegetable seeds imported, the rest being imported by private individuals.

Fresh Vegetables

Apart from potatoes, mainly from Portugal and Holland, vegetable importations are small, as is to be expected. The following have been inspected on arrival by air: Celery and Leeks from England, Mint, Parsley and Cabbage from the Lebanon.

Fruits

The following have been inspected on arrival by air (apart from fruits from temperate countries): Citrus, watermelons, fresh figs, olives, grapes, strawberries (Symphoricarpus), mangosteen (Garcinia sp) from the Lebanon.

Nuts

The following, imported from the Lebanon, were examined: Pistadio nuts, Groundnuts, *Cuyperus esculentus* tubers, and coconuts.

Vegetative material of crop plants

The following were imported through the Plant Quarantine Service: Cassava from the Malagasy Republic, and *Panicum purparescens* from Ghana, Hevea rubber from Liberia and West Cameroon, strawberries from France, *Dioscorea* spp. from British Honduras. Consignments imported before the period of this report but not released from quarantine until after 31st April, 1961 consisted of cocoa from Ghana and sugar cane from Kenya and Australia.

Seeds of Crop Plants

Introductions during the period included the following: Cocoa from Ghana; rice from Malaya, Italy and Senegal; oil palm from Dahomey and Malaya; pawpaw from Hawaii and Italy; wheat from U.S.A. and Libya; pecans from U.S.A.; cassava from Ghana; sorghum from Israel; beniseed from Venezuela.

Vegetative Material of Ornamental Plants

Roses constituted the largest category, over forty consignments being examined (from the United Kingdom, France and Ireland). Other ornamentals imported from the United Kingdom included *Anthemis; Dianthus* (carnation); *Begonia* spp; *Gladiolus; Lilium* spp; *Pelargonium; Erigeron; Eryingium; Chelone; Gymnadenia; Physostegia.* Apart from *Gladiolus,* other plants from the Netherlands, included Dahlia, Freesia, *Ranunculus* and *Tigridia.*

Cut Flowers

The checking of cut-flowers and other plants for decoration, etc., at the port of entry gave records of the following which have been inspected during the second half of the period, from the United Kingdom, the Netherlands and France: Carnations, Chrysanthemums, *Digitalis* sp., *Hippeastrum* sp., Holly (*Ilex aquifolium*); *Narcissus* spp; Nasturtium (*Tropaeolum* sp.); Mistletoe (*Viscum album*); Orchids; Roses; *Tagetes* spp; Tulips.

Forest Tree Seeds

A large number of species of Eucalyptus and other economic trees have been imported through the Plant Quarantine Service by the Federal Department of Forestry Research.

Interceptions

The following imports have been destroyed on arrival: Plants of *Sanseveria* in soil from Dakar, Shamrock (*Trifolium* repens) in soil from Ireland, plants of *Picea* from United Kingdom. Sugar cane cuttings from Trinidad.

Inspection

The numbers of separate consignments inspected during the year at four Plant Quarantine Stations were as follows:—

Ibadan	... ...	79
Lagos	... ...	213 (Began September 1961)
Kano	... ...	163 (Began October 1961)
Calabar	... ...	5
Total	... ...	460

Quarantine

During the period under review only four batches of imported plant material have been grown under observation in the Plant Quarantine houses, apart from cocoa. These were sugar cane cuttings from Australia and Kenya, pawpaw seeds from Hawaii, and Cassava cuttings from the Malagasy Republic. The sugar cane and pawpaw were released during the year, the cassava was still in quarantine at the end of the period. In October 1961, 60 clones of cocoa were released from quarantine, together with 260 cuttings taken from them, after virus indexing. Three hundred and seventy budded plants of clonal cocoa were taken into quarantine for virus testing during the year.

Plant Introduction

In order to reduce the amount of plant importation into Nigeria, particularly of economic plants, a list of all plants introduced in 1961 through the Plant Quarantine Service, was circulated to Botanists, Plant Breeders, Agriculturists and Planters in Nigeria at the beginning of 1962. By this means it is hoped that greater interchange of plant material will take place between specialists and growers within the country, and re-importation of the same variety, or clone, of a plant, with its attendant phytosanitary risks, avoided.

Plant Exportation

One hundred and twenty consignments of plants and plant products were inspected during the year at Ibadan and issued with Phytosanitary Certificates, most of them after treatments against pests and diseases. The majority have been seeds for propagation, and products for processing. The question of phytosanitary certification of bulk shipments of beniseed, cotton-seed, cotton lint, palm-kernels and groundnuts, which is requested for certain importing countries, will continue to be an unresolved problem in the absence of large-scale fumigation equipment at Nigerian ports. At present a certificate is issued on examination of a representative sample which is, of course, valueless from a phytosanitary point of view.

Vegetative material for propagation which has been exported through the Plant Quarantine Service included cocoa budwood for Ghana and Ivory Coast, rubber budwood for the Republics of Cameroun and Congo, sugar cane cuttings to Ghana, and several consignments of ornamental plants to the United Kingdom, including orchids.

Legislation and Regulations

The Agriculture (Control of Importation) Act, 1959, was amended by the Agriculture (Control of Proceedings) Act, 1961, which came into force on 26th December, 1961. This Act restricts the power to institute proceedings for an offence against the 1959 Act, to the Attorney-General of the Federation.

The enforcement of the Regulations under the 1959 Act was delayed, pending the amendment, and in March the draft Regulations were submitted by the Director of Agricultural Research in a revised form, for consideration by the Ministry of Justice. The Draft Regulations have been modelled to conform with the co-ordinated legislation of the Inter-African Phytosanitary Commission.

Training of Staff

It is proposed that the in-service training in Plant Quarantine Techniques which is given to Junior Staff, should be organised as a formal annual course of three months duration, with a set syllabus. It will comprise lectures and practical training in Plant Pathology, Entomology and Plant Quarantine Principles and Techniques. A certain amount of preliminary work was done in drawing up the course, the first one of which is planned to start in April 1963. After receiving the training, junior staff of Agricultural Assistant grade will be qualified to act as Plant Quarantine Inspectors at the Plant Quarantine Stations, under the supervision of Plant Quarantine Officers.

Publicity

The presence of Inspectors at the ports when passengers arrive in Nigeria has proved to be the best form of publicity so far ; this is backed up by the fact that all persons receiving plant materials by mail have been sent a copy of the Inspection Certificate, for information. The number of enquiries regarding Plant Quarantine rose sharply towards the end of the period. Four different posters have been displayed at airport baggage halls and the Apapa passenger Customs hall, drawing attention to the Plant Quarantine Service and the need to declare plants and seeds in personal effects.

Two items of office organisation have also served to publicise the Plant Quarantine Service ; the conspicuous green and white label which is supplied for the use of importers of restricted plant materials which must be inspected on arrival in Nigeria has been helpful in acquainting other Government Services of the control of plant importation ; the telegraphic address "Phytosan" used for all four stations has helped agriculturists and others to get in touch with the Plant Quarantine Service quickly if necessary and the name seems to be easily remembered.

The illustrated folder on Plant Quarantine has been printed and it is proposed to send it to all private individuals and commercial organisations, who have imported plants or seeds during the past two years, on the publication of the new Regulations, together with a copy of the Regulations. A card index of importers is kept in the main Plant Quarantine Office, which is compiled using the reports from Lagos and Kano of inspected plants, and this forms the basis of the Plant Quarantine Publicity "mailing list", together with the names and addresses of all persons who have requested import permits or made any queries about Plant Quarantine. The folder will also be given to applicants for visas through Nigerian Overseas Mission and to intending travellers to Nigeria by shipping and air-line agents.

LIBRARY

The Library moved into new premises in August 1961, which for the first time provide adequate reading-room facilities, staff work-rooms and stackroom accommodation. This made possible the incorporation of the small library of the former West African Maize Research Unit into the main library stocks, and the sorting and shelving of much previously unsorted material. The U.D.C. system of classification has been introduced, and a start made on the building up of a classified catalogue. The total number of volumes in the library is now 2,600, of which 1,500 are books. The total number of periodical titles represented is 258, 153 being currently received. Satisfactory progress has been made in making good the backlog of binding, with particular reference to current titles.

Loan records have been kept for the first time, and cover only the period from June 1961 to March 1962. The number of loans to Departmental staff was 261, and to external personal borrowers 70. The number of current periodical issues circulated to staff was 433. 40 publications were borrowed from external sources, and one lent. 30 microfilm copies of periodical articles not available locally were purchased, and 55 photo copies made by the Departmental photographer.

Departmental publications, listed below, have been prepared for the press, and distributed locally and overseas from the library. The distribution of the Nigerian allocation of FAO publications has also been taken over, and is at present being made on the basis that three copies of each publication are sent to the Ministry of Agriculture in each Region, the remaining copies being distributed among Federal Ministries and research organisations according to their subject interest.

PUBLICATIONS

External Publications

CHINWUBA, P. M. *et al.*—Interaction of detasseling, sterility and spacing on yields of maize hybrids. *Crop Sci.,* July-August 1961, p. 279.

EIJNATTEN, C. L. M. *van.*—A varietal improvement programme on maize in Nigeria. Euphytica, May 1961, *10,* 294-300.

EIJNATTEN, C. L. M. *van.*—Susceptibility to leaf blight, caused by *cochliobolus heterostrophus,* in Nigerian varieties of maize. *Nature,* July 1961, *191* (4787), 515-516.

HARRIS, K. M. ... ... The Sorghum midge, *Contarinia Sorghicola* (Coq) in Nigeria. *Bull. Ent. Res.,* April 1961, *52* (1), 129-146.

HARRIS, K. M. ... ... Sorghum midge, *Contarinia Sorghicola* (Coq), in West Africa. *Nature,* October 1961, *192* (4798), 187-188.

MOUND, L. A. ... ... A new genus and four new species of whitefly from ferns (Homoptera, Aleyrodidae). *Rev. Zool. Bot. Afr.* October 1961, *LXIV* (1-2), 127-132.

MOUND, LAWRENCE A. — A pyralid of moth from Ants' Nests in Nigeria. *The Entomologist,* January 1961, 20-21.

Departmental Publications

Annual Report

Annual Report of the Department of Agricultural Research for the year 1959-60. Lagos, Federal Printing Division, 1961.

A guide to the Federal Department of Agricultural Research, Nigeria, Ibadan, 1961.

Publications of Nigeria Agricultural Departments 1910-1961. With appendix: Publications of West African Maize Research Unit 1953-1960. Ibadan, 1962.

Memorandum

No. 27 *Eijnatten, C. L. M. van.*—On the assessment of blight on leaves of maize, caused by *cochliobolus heterostrophus.* July 1961.

No. 28 *Eijnatten, C. L. M. van.*—Selection for combining ability within the variety *sicaragua.* July 1961.

No. 29 *Ekandem, M. J.*—Preparation of cassava in the human diet of Nigeria. September 1961.

No. 30 *Spencer, R.*—Analytical methods at present used to determine plant nutrient status and readily available nutrients in the soil by the Federal Department of Agricultural Research, Ibadan. 1961.

No. 31 *Waitt, A. W.*—Review of yam research in Nigeria 1920-61. November 1961.

METEOROLOGICAL STATION, MOOR PLANTATION (0703.25B)

REPORT ON RAINFALL

JANUARY-DECEMBER 1961

Months	*Rainfall in Inches*	*10 Years average in Inches*	*No. of Wet Days*	*Cumulative Total in Inches*
	10.00 *a.m.*	—	—	—
January	0.10	0.29	1	0.10
February	—	1.15	—	0.10
March	1.76	4.26	4	1.86
April	4.61	5.24	10	6.47
May	5.96	6.41	12	12.43
June	6.86	7.58	17	19.29
July	5.67	5.55	24	24.96
August	1.38	3.07	5	26.34
September	4.14	7.00	19	30.48
October	8.11	7.70	19	38.59
November	1.20	2.41	1	39.79
December	—	0.32	—	39.79
TOTAL	39.79	50.98	112	—

METEOROLOGICAL STATION MOOR PLANTATION (0703.25B)

REPORT ON RAISED AND SUNKEN EVAPORATION TANKS

JANUARY-DECEMBER 1961

Months	*Raised Tank Evaporation*			*Sunken Tank Evaporation*
	No. of Cups Added	*No. of Cups Withdrawn*	*Evaporation in Inches*	*Evaporation in Inches*
		10.00 *a.m.*		10.00 *a.m.*
January	215	—	4.40	4.40
February	276	—	5.52	5.52
March	294	45	6.74	6.74
April	165	134	5.23	5.23
May	134	189	4.86	4.86
June	101	256	3.76	3.76
July	57	192	2.97	2.97
August	119	52	2.72	2.72
September	87	135	3.18	3.18
October	95	261	4.79	4.79
November	219	42	4.26	4.26
December	224	—	4.48	4.48
TOTAL	1,986	1,306	52.91	52.91
MEAN	166	109	4.41	4.41

METEOROLOGICAL STATION—MOOR PLANTATION (0703.25B)

REPORT ON EVAPOTRANSPIROMETER

JANUARY-DECEMBER 1961

Months	*Mean Screen Maximum* °F	*Mean Screen Minimum* °F	*Mean Dry* °F	*Mean Wet* °F	*Addition In* cc	*Overflow In* cc
	10.00	*AM*	4.00	*PM*	8.00 *a.m.*	8.00 *a.m.*
January	92.6	70.3	91.1	75.9	46,500	34,350
February ..	96.8	68.5	95.8	72.2	42,000	6,310
March	97.8	72.2	96.3	76.1	46,500	11,820
April	90.8	71.3	89.5	78.0	45,000	46,130
May	90.1	71.5	87.6	78.9	46,500	63,930
June	85.6	69,6	81.4	76.0	45,000	69,740
July	81.5	69.8	78.9	74.4	46,500	65,380
August	81.7	67.0	80.3	73.8	46,500	41,960
September ..	84.7	68.6	82.1	74.7	45,000	53,030
October	88.7	68.9	86.1	77.2	46,500	73,310
November ..	92.1	71.5	89.9	77.4	45,000	27,020
December ..	93.0	68.1	92.0	73.7	46,500	15,770
TOTAL ..	1075.4	837.3	1051.0	908.3	547,500	508,750
MEAN ..	89.6	69.8	89.6	75.7	45,642	42,396

METEOROLOGICAL STATION—MOOR PLANTATION (0703.25B)

REPORT ON SUNSHINE

JANUARY-DECEMBER 1961

Months	*Duration of Monthly Sunshine in Hours*	*Mean Duration of Sunshine in Hours*
January	203.2	6.55
February	212.1	7.86
March	183.4	5.92
April	172.5	5.75
May	185.4	5.98
June	136.8	4.56
July	55.7	1.80
August	80.4	2.59
September	69.7	2.32
October	169.3	5.46
November	232.3	7.74
December	257.7	8.31
TOTAL	1,958.5	64.84
MEAN	163.1	54.0

Meteorological Station Moor Plantation (0703.25B)

REPORT ON TEMPERATURE DATA

January-December 1961

Months	Mean Maximum °F	Mean Minimum °F	Mean Dry °F	Mean Wet °F	Mean Relative Humidity % 10.00	Mean Grass Minimum °F A.M.	Mean Earth 1 Ft. °F	Mean Earth 4 Ft. °F	Mean Dew Point °F	Mean Vapour Pressure MBS	Anemometer Mean Wind Runs Miles	Mean Water Maximum °F	Mean Water Minimum °F	Mean Dry °F	Mean Wet °F 4.00	Mean Relative Humidity % P.M.	Mean Earth 1 Ft. °F	Anemometer Mean Wind Runs Miles	Mean Dew Point °F	Mean Vapour Pressure MBS
January ..	92.6	70.3	80.1	74.6	76.9	68.6	86.2	86.2	71.5	27.0	28.18	89.2	69.0	91.1	75.9	48.3	87.8	28.69	68.2	24.0
February ..	96.8	68.5	80.8	72.8	67.5	66.1	89.2	88.0	67.9	24.3	37.56	90.9	68.1	95.8	72.2	29.0	91.2	37.49	57.7	16.6
March ..	97.8	72.2	84.3	76.6	69.6	71.2	92.3	91.2	72.5	27.9	54.04	93.4	71.3	96.3	76.1	38.0	94.4	54 01	65.5	21.8
April	90.8	71.3	80.9	76.3	80.5	71.1	87.0	89.3	74.2	28.9	46.66	91.9	69.3	89.5	78.0	58.9	89.2	46.28	72.6	27.7
May	90.1	71.5	82.1	77.4	80.5	71.9	86.1	87.8	73.1	30.1	38.91	92.5	70.8	87.6	78.9	67.8	88.2	38.94	75.3	29.9
June	85.6	69.6	78.7	75.5	83.8	69.8	83.6	85.8	71.0	27.9	47.23	87.0	67.3	81.4	76.0	77.8	85.1	47.22	71.1	28.3
July	81.5	69.8	75.4	72.7	87.5	70.2	81.5	83.7	71.5	26.2	59.03	86.7	65.3	78.9	74.4	80.7	82.2	60.03	72.1	27.0
August ..	81.7	67.0	74.5	71.1	84.0	65.6	80.2	82.0	69.4	24.4	45.05	86.8	63.2	80.3	73.8	72.9	81.0	45.32	70.8	25.5
September ..	84.7	68.6	75.9	72.7	83.8	68.1	81.2	82.1	71.0	25.9	34.50	89.7	64.9	82.1	74.7	70.0	82.1	32.79	71.2	26.1
October ..	88.7	68.9	79.6	75.2	80.9	68.7	82.9	83.3	73.2	27.9	26.42	95.0	66.9	86.1	77.2	65.5	84.5	26.07	73.2	27.9
November ..	92.1	71.5	80.8	76.4	81.3	69.7	85.6	85.4	74.6	29.2	23.25	97.0	69.1	89.9	77.4	55.4	87.3	23.25	71.6	26.6
December ..	93.0	68.1	79.2	73.5	75.2	64.6	85.5	85.8	70.4	25.8	28.05	93.0	66.7	92.0	73.7	40.1	87.0	28.12	63.7	20.3
Total ..	1,075.4	837.3	952.3	894.8	951.5	825.6	1,021.3	1,030.6	860.3	325.5	468.94	1,093.1	811.9	1,051.0	908.3	704.4	1,040.1	468.21	833.0	301.7
Mean ..	89.6	69.8	79.4	74.6	79.3	68.8	85.1	85.9	71.7	27.1	39.08	91.1	67.7	87.6	75.7	58.7	86.7	39.02	69.4	25.1

TABLE 1.—SHOWING PROGRESS OF RECURRENT AND WASTAGE OF PROFESSIONAL STAFF IN THE FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH AS AT MARCH 1953-62.

Professional Establishment	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	*Total for 10 years*
Authorised ..	19	19	20	20	26	46	46	43	43	43	—
Actual	11	11	13	15	14	15	20	20	23	25	—
No. recruits ..	2	1	4	3	3	3	9	5	4	6	40
Wastage (deaths, retirements or transfers) ..	—	1	2	1	4	2	4	5	1	4	24

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